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# DIRECT BENEFITS OF THE RED DEER RIVER BASIN DEVELOPMENT

Progress Report Number I

A.R.D.A. Project #28014

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Economics Division
Alberta Department of Agriculture

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## A.R.D.A. Project #28014

G. B. Parlby
Project Leader

Production Research Branch
Economics Division
Alberta Department of Agriculture

Honorable H. A. Ruste - Minister     Dr. E. E. Ballantyne - Deputy Minister

## PREFACE

The Prairie Rivers Improvement and Management Evaluation (PRIME) is a water plan broad in scope and covering the whole of Alberta. PRIME is a long range planning and development program designed basically to provide for water storage in headwater regions and for diversions of water to areas and uses of greatest need in the Province.

The Red Deer River Basin Development Program is a small but integral part of the PRIME water plan. This, the formerly William Pearce Scheme, includes a number of development proposals for the Basin affecting water supplies in its many uses. The Water Resources Division, Alberta Department of Agriculture is making engineering investigations of these proposals and the Economics Division is carrying out socio-economic feasibility studies.

This is the first progress report of economic studies conducted under the project leadership of G.B. Parlby. The report includes a description and assessment of possible benefits accruing to the project for recreational purposes, flood protection, domestic water use, irrigation, stock watering and for industrial water use and polution abatement.

Further investigations are required on the engineering, economic and social aspects of the program before study can be considered complete. In the interim, this report shows the progress of economic studies to date and this will undoubtly be of value in planning for water development.

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Knud Elgaard,
Assistant Director.

## ACKNOWLEDGEMENTS

The progress to date with this study has been the combined effort of many people. Their contributions whether through provision of information, guidance in analysis, or compilation of the report is gratefully acknowledged. Particular thanks are expressed as follows:

To Mr. K. Elgaard, Mr. B.J. McBain, Mr. Len Bauer, Mr. Jack Gorr, Mr. T. Williams and Mr. J. Bigam of this Division thanks are extended for consultations in determining the approach taken and the techniques adopted.

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To the others acknowledgements are extended in footnotes throughout. The results as they are interpreted and presented are the responsibility of the author.

G.B. Parlby
Project Leader

## TABLE OF CONTENTS

PREFACE . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . i
ACKNOWLEDGEMENTS . . . . . . . . . . . . . . . . . . . . . . . . ii
TABLE OF CONTENTS . . . . . . . . . . . . . . . . . . . . . . . . iii
LIST OF TABLES . . . . . . . . . . . . . . . . . . . . . . . . . . iv
LIST OF MAPS . . . . . . . . . . . . . . . . . . . . . . . . . . . vi
LIST OF FIGURES . . . . . . . . . . . . . . . . . . . . . . . . . vi
INTRODUCTION . . . . . . . . . . . . . . . . . . . . . . . . . . . vii

SECTION I: Recreation . . . . . . . . . . . . . . . . . . . . . . 1

SECTION II: Flood Protection . . . . . . . . . . . . . . . . . . 18

SECTION III: Domestic Water . . . . . . . . . . . . . . . . . . 24

SECTION IV: Irrigation . . . . . . . . . . . . . . . . . . . . . 55

SECTION V: Stockwater . . . . . . . . . . . . . . . . . . . . . 73

SECTION VI: Industrial Water and Pollution Abatement Benefits . . . . . . . . . . . . . . . . . . . . . . . . . 96

SECTION VII: Summary . . . . . . . . . . . . . . . . . . . . . . 100

## LIST OF TABLES

Table 1 - Attendance at Rochon Sands Provincial Park . . . . . . . 2

Table 2 - Recreational Potential of Four Central Alberta Lakes . . 7

Table 3 - Outward Movement of Water for Four Central Alberta Lakes . . . . . . . . . . . . . . . . . . . . . . . . 9

Table 4 - Urban Population by Distance Zones for Buffalo Lake . . 10

Table 5 - Density of Cottage Development per Mile of Shoreline Suitable for Cottage Sites . . . . . . . . . . . . . . . . 12

Table 6 - Proportions of the 1966 Urban Population Within Expanding Distance Zones from Four Central Alberta Lakes 13

Table 7 - Variation of Lot Values at Four Central Alberta Lakes . 14

Table 8 - Populations of Centres Within Improvement District #42 . . . . . . . . . . . . . . . . . . . . . . . 18

Table 9 - Frequency - Damage Relationships, Drumheller . . . . . . 22

Table 10 - Average Annual Damages, Drumheller . . . . . . . . . . . 22

Table 11 - Population Using Domestic Water in the Distribution Area . . . . . . . . . . . . . . . . . . . . 28

Table 12 - 1966 Consumption Levels for Various Centres in the Distribution Area . . . . . . . . . . . . . . . . . . . . 29

Table 13 - Characteristics of Present Water Supply and Disposal Systems in the Distribution Area . . . . . . . . . . . . 30

Table 14 - Indications of Rationing of Water in Urban Centres in the Distribution Area . . . . . . . . . . . . . . . . . 33

Table 15 - Chemical Analysis of Water Supplies for Various Urban Centres in the Distribution Area . . . . . . . . . 36

Table 16 - Classification of Groundwater Wells by Total Solids Content . . . . . . . . . . . . . . . . . . . . . . 38

Table 17 - Population Data, Historical Trends, Projections to 1976 and 1986, Distribution Area . . . . . . . . . . . . 41

Table 18 - Total Employment by Industry, Distribution Area, 1961 . 42

Table 19 - Population Projections by Agricultural Employment, Distribution Area, 1966 . . . . . . . . . . . . . . . . . 43

Table 20 - Consumption Revenue and Expenditure Information for Various Cities, Towns and Villages in Alberta, 1967 . . 48

Table 21 - Estimated Relevant Annual Costs for Water Supplies . . . 52

Table 22 - Estimated Desalination Costs for Three Centres in the Distribution Area . . . . . . . . . . . . . . . . . . . 53

Table 23 - Water Purchases From Irrigation Districts . . . . . . . . 54

Table 24 - Land Use In the Distribution Area . . . . . . . . . . . . 55

Table 25 - Commercial Farms Classified by Product Type for the Distribution Area . . . . . . . . . . . . . . . . . . 56

Table 26 - Economic Classes of Commercial Farms Within the Distribution Area, 1966 . . . . . . . . . . . . . . . . 57

Table 27 - Comparative Measure of Climate . . . . . . . . . . . . 58

Table 28 - Seasonal Consumptive Use of Water by Crop Grown Under Irrigation Conditions . . . . . . . . . . . 59

Table 29 - Estimated Land Use Patterns Dryland and Irrigation Situations . . . . . . . . . . . . . . . . . . . . . . 63

Table 30 - Estimated Gross Returns per Cultivated Acre, Dryland Situation . . . . . . . . . . . . . . . . . . . . 64

Table 31 - Estimated Total Costs of Production per Cultivated Acre, Dryland Situation . . . . . . . . . . . . . . . . 65

Table 32 - Estimated Gross Returns per Cultivated Acre, Irrigation Situation . . . . . . . . . . . . . . . . . . 67

Table 33 - Estimated Total Costs of Production per Cultivated Acre, Irrigation Situation . . . . . . . . . . . . . . 68

Table 34 - Estimated Net Direct Benefits for Irrigation, Distribution Area . . . . . . . . . . . . . . . . . . . . 70

Table 35 - Development Period, Eastern Situation - St. Mary and Milk Rivers Development . . . . . . . . . . . . . . 71

Table 36 - Proportion of Unimproved Range . . . . . . . . . . . . 73

Table 37 - Livestock Numbers . . . . . . . . . . . . . . . . . . . 74

Table 38 - Acres Served by a Water Facility South Portion Special Area #3, 1966 . . . . . . . . . . . . . . . . . 82

Table 39 - Progress in Water Development for Stock to 1967 - Survey Area #2 . . . . . . . . . . . . . . . . . . . . 84

Table 40 - Estimated Severity of Shortage 1911 - 56, 1960 - 66 . . . 90

Table 41 - Weighted Average Prices of Beef, 1957 - 1966 . . . . . . 91

Table 42 - Dry Feed Equivalent Value of Pasture . . . . . . . . . . 93

Table 43 - Estimated Animal Unit Months of Grazing Served by Surface Water Facilities . . . . . . . . . . . . . . . . 94

Table 44 - Estimated Average Annual Shortage Expressed in Animal Unit Months . . . . . . . . . . . . . . . . . . . . . . 95

Table 45 - Estimated Net Direct Benefits and Annual Value per A.U. Year . . . . . . . . . . . . . . . . . . . . . . . 95

Table 46 - Projected Population, Wastes, and Costs of Pollution Abatement for the City of Red Deer . . . . . . 98

## LIST OF MAPS

Proposed Dam Sites and Canal Routes . . . . . . . . . . . . ii
Access Routes to Buffalo Lake . . . . . . . . . . . . . . . 11
City of Drumheller Base Map . . . . . . . . . . . . . . . . 21
Towns, Village and Hamlets Within the Distribution Area . . . . . . . . . . . . . . . . . . . 25
Census Division Boundaries, Distribution Area . . . . . . . 26
County Boundaries, Distribution Area . . . . . . . . . . . 27
Median Annual Unit Runoff and Runoff Variability . . . . . 76
Stockwater Survey Area . . . . . . . . . . . . . . . . . . 81

## LIST OF FIGURES

Figure 1: Comparative Changes in Lake Levels For Period of Continuous Record . . . . . . . . . . . . . . . . . 8
Figure 2: Damage - Frequency Curve, Drumheller . . . . . . . . 23
Figure 3: Historical Population Trends and Projections, Distribution Area . . . . . . . . . . . . . . . . . . . 44
Figure 4: Demand for Domestic and Industrial Water Various Alberta Urban Centres, 1966 . . . . . . . . . 47
Figure 5: Simple Correlation Showing the Relationship of Water Facilities to 1966 Stocking Rates . . . . . . . 83
Figure 6: Occurence and Severity of Stock Water Shortages . . . 89

# Introduction

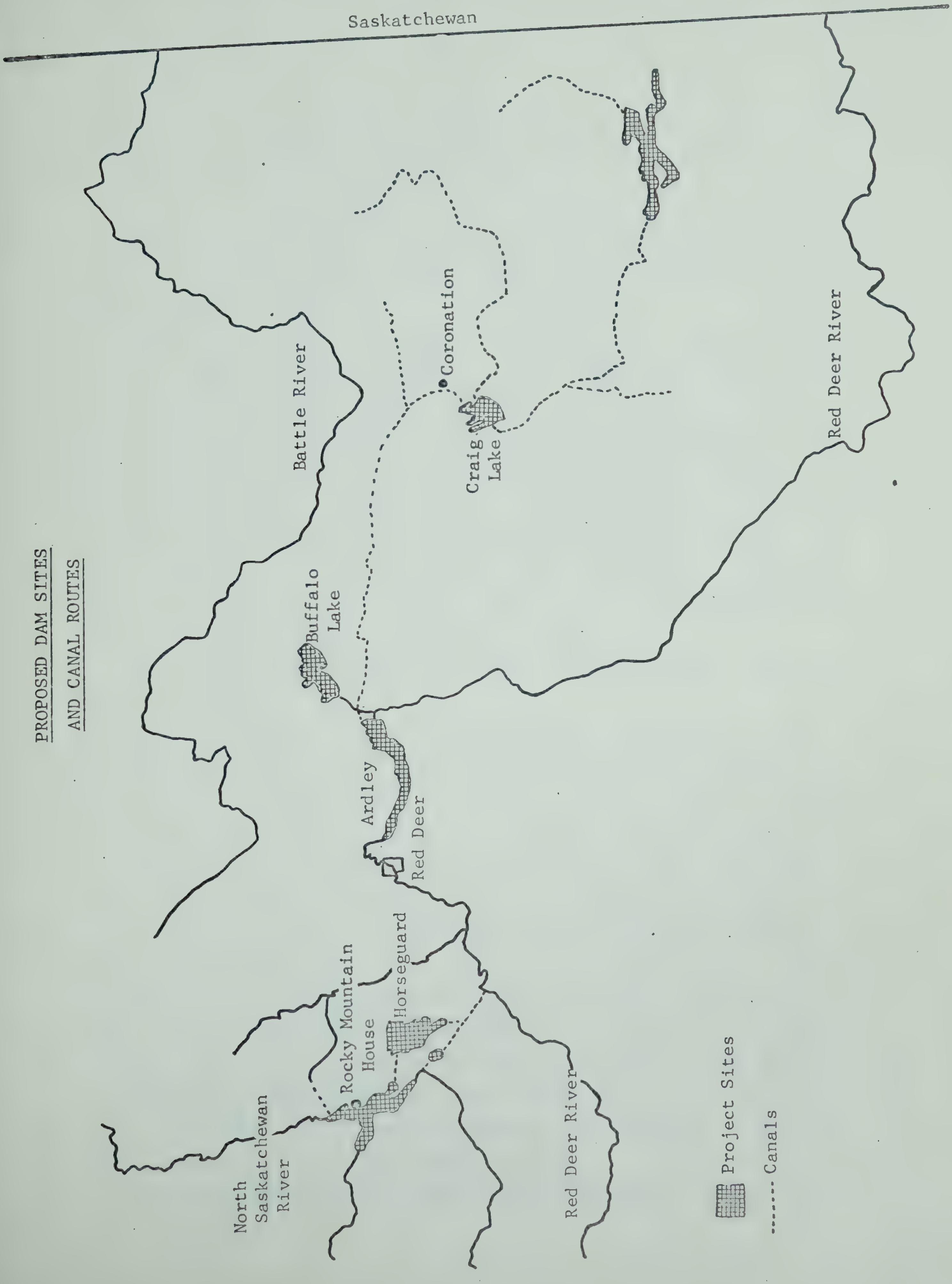
In the early part of 1966, a request was received by the Economics Division of the Alberta Department of Agriculture to begin socio-economic studies on the Red Deer River Basin Development. The request was sent from the Water Resources Division of the same department. The study was intended to provide a basis upon which policy-makers could make decisions on the project's feasibility and by which engineers could select the best combination of uses of water within the basin. The study, which began in July of 1966, was financed jointly by the Agricultural Rehabilitation and Development Act and the Alberta government.

The Red Deer River Basin Development, at the time of initiation of the study, was planned in broad principle. Water would be stored at one or more potential storage sites on the headwaters of the Red Deer. Then by means of canal and river with additional dams at Ardley or Nevis, the water would move eastward into the dry short grass plains of East Central Alberta. The distribution area was broadly defined as those lands bounded by the Red Deer River on the south, the Battle River on the north, the west boundary of the County of Stettler on the west and the Alberta Saskatchewan border on the east.

In the period since 1966, the plan of development has been narrowed to a tentative diversion of the North Saskatchewan at Rocky Mountain House into a storage reservoir called the "Horseguard site" from which water would flow into the Red Deer River and down to the "Ardley" dam site about 25 miles east of the city of Red Deer. Water would then flow through a main canal extending out to a reservoir at Craig Lake south of the town of Coronation. Buffalo Lake near Ardley was proposed as a secondary storage site. Canal locations beyond Craig Lake, are still undetermined pending furthur investigation into specific locations of project water use including the location of irrigable soils and local ground water supplies. A map on page viii provides the general outline of the project as it stands at present.

The benefits that were hypothesized as justification for the project included conservation of water in the head waters; stabilization of river flows on the Red Deer; a consequent increase in the amount of pollutant which could be discharged into the Red Deer river during low winter flows;

PROPOSED DAM SITES AND CANAL ROUTES



the reduction of flood damages at Drumheller; the creation of recreational areas around damsites; the improvement of the recreational potential of Buffalo Lake; and the improvement of domestic, industrial, stock and supplementary irrigation water supplies within the distribution area. By introducing water into the eastern area, the wildlife habitat, especially for geese and ducks, would be more stable and thus be a further benefit from the project.

This report presents the progress of the economic studies to September 1st, 1968. It can not be considered complete because planning has not yet proceeded to the point where preliminary cost estimates of the project are available. Knowledge on the quantity of irrigable soils is still too general to provide concrete estimates of the benefits involved. These will no doubt become available as funds and priorities on other work permit. However, this report will provide information, accumulated to date. The data will help in the selection of the alternatives still available for the many uses of water within the project and in so doing maximum benefits should be obtained for the intended investment.

In economic terms, benefits and costs are of two types. These are direct or indirect.

Direct benefits are the expected increases in the production of goods and services as a result of the construction of the project. They are measured by estimating the total production from the use of water with the project and subtracting from this the present production without it.

Direct costs are either associated or project costs. Associated costs are those costs of capital, labor, land and management used to produce the direct benefits. For irrigation, they would be the farmer's costs. For domestic water, they would be the cost of storing, treating and distributing raw water purchased from the project. Only costs in addition to those already incurred without the project are considered. Project costs are those directly incurred in the construction, operation and maintenance of the project. These include the capital invested to build the project, the labor and management used to operate it and the costs incurred in repairing it over its life.

A direct benefit to cost ratio indicates the economic feasibility of

the project from a repayment point of view. Users can be isolated and charged on a voluntary or taxation basis.

Indirect benefits arise from the additional economic activity created by the project in transporting, processing and marketing new production. These are classed as benefits "stemming from" the project. As well purchases for the project and its newly created production create a demand for more goods and services within the economy. These benefits are "induced by" the project. For these indirect benefits indirect costs are incurred. It is only the additional benefits over costs which can be attributed to the project and these depend on what point of view is adopted. Nationally, indirect benefits are not significant under conditions of full employment. Locally they are very important as they indicate the increased level of economic activity in the community. For preliminary analysis, indirect benefits and costs have not been taken into account.

It was decided to adopt the following procedures because defined areas of water use were not initially available.

(1) Direct benefits would be estimated on a per unit basis. For example, $ per irrigable acre, $ per lot for a cottage, $ per animal unit grazed.

(2) Associated costs would be estimated on a similar basis.

(3) The difference between these would provide a measurement of the net direct benefit on a per unit basis.

(4) The net direct benefit per unit could be aggregated as quantitative measurements became available and compared to project costs. This would provide one basis for decisions on inclusion or exclusion of areas within the project where benefits would be less than costs.

(5) Net direct benefits were computed on an annual basis. Rather than discounting these benefits over the life of the project and obtaining the present value of all benefits for comparison with construction cost estimates, the intention is to amortize the construction costs over the life of the project at an appropriate interest rate and combined with operation and maintenance costs compare these with the annual net benefits as decisions are being made.

(6) Associated costs were charged through at an interest rate of 5% which is low at the present time but is considered to be more consistent with long term trends.[1/]

This report covers investigations into five major benefits of the project. These are recreation, flood control, domestic water use, supplementary irrigation and stock water use. Indications are given on the general extent of pollution and industrial water benefits, but they are not discussed or measured in detail.

---

[1/] Inman, M.K., Economics in a Canadian Setting, The Copp Clark Publishing Co. Limited, 1959.

# Section I

## RECREATION

### General

Recreation in its broadest sense could be defined as the act of refreshing one's self through partaking in some pleasant pastime, amusement or occupation. In today's world, recreation is synonomous with the use of leisure time. Leisure time refers to available hours within the week not used for working. With the work week varying from five to six days in this province and the average income of much of the population providing a standard of living beyond the basic necessities of food, clothing, shelter and health care, the importance of recreation during leisure time has increased.

Outdoor recreation is one broad category of activities. Within this field of activity hunting, fishing, sight seeing, camping, hiking, swimming, boating, and water skiing, immediately come to mind. Water is an important component in most of these activities.

### The Area

While some recreational potential is available throughout the development, major areas which can be pointed out for investigation are the upstream reservoirs, the "Ardley site", Buffalo Lake and the goose and duck country within the distribution area. The Rocky Mountain House site and the Horseguard site are being investigated on a preliminary planning basis. If adopted, their size alone could indicate something of their potential for recreational use. The Rocky Mountain House site will cover an area of 10,319 acres and hold 318,400 acre ft. The Horseguard site will cover an area of 15,950 acres and has a capacity of 476,000 acre ft. These sites do have an important locational factor, as both lie near the David Thompson Highway which starts at Rocky Mountain House and joins the

Banff-Jasper Highway at the Saskatchewan River Crossing. Consequently these sites may be important as a tourist attraction. While nothing more can be said about these sites at the moment, general comments on the "Ardley site" will provide indications on their future potential.

The "Ardley site" covers an area of 7,470 acres and has a capacity of 607,830 acre feet. At present, without the dam, the area surrounding the reservoir supports recreational activities such as angling, canoeing, camping, hunting, sight seeing and skiing.[2/]

Buffalo Lake is located about 35 miles east of Lacombe. The lake covers an area of 80,000 acres and has a capacity of 1,581,000 acre feet. Its natural attributes of beach and scenic beauty have been developed to a point where a major provincial park, which provides facilities for campers and day users, is located at Rochon Sands. Attendance at Rochon Sands has been recorded for the last four years and is presented in Table I in the form of user days. A user day is defined as one person who attends the lake for a portion of or the full period of twenty four hours.

### TABLE 1

### ATTENDANCE AT ROCHON SANDS PROVINCIAL PARK [3/]

| Year | User Days |
|---|---|
| 1964 | 76,098 |
| 1965 | 60,676 |
| 1966 | 82,084 |
| 1967 | 105,097 |

---

[2/] Munn, B., Possible Recreation Potential of the Proposed Ardley Reservoir, Parks Planning Branch, Department of Lands and Forests, Unpublished Report to the Water Resources Division, 1968.

[3/] Attendance Reports - Parks Planning Branch, Department or Lands and Forests.

Cottage developments are confined to Rochon Sands and Pelican Point. In 1967, there were one hundred and fourty seven cottages at these two locations.

The large game bird population nesting within the distribution area is complemented by those using the area as a resting or staging place on their migrations. The area is part of the Central and Pacific Flyways which makes a major contribution to the provincial geese kill. Forty-five percent of all geese killed in the province in 1966 were bagged in East Central Alberta. Including sharp tailed grouse, Hungarian partridge, geese, ducks and other birds, the distribution area provided 100,000 hunter days of recreation in 1966.[4/]

## The Hypotheses

The probable benefits from the project with regard to recreation require some delineation before they can be specifically stated. In broad generalities the effects of new water bodies such as the Rocky Mountain House, Horseguard and Ardley sites would be the provision of places for water based recreation activities such as fishing and boating. As the population grows within the province, these sites will provide areas where recreationers can satisfy their needs. Buffalo Lake, already a recreation site, will be improved. Reservoirs and canals within the distribution system will improve the staging areas for geese, increase the number of local birds reared and thereby increase the recreational potential for hunting. This section is based on the above hypotheses.

---

[4/] Kerr, G.R., Chief Wildlife Biologist, Fish & Wildlife Branch, Dept. of Lands & Forests, "Correspondence with C.L. Primus, Water Resources Division 1967."

## Procedure

The first step in the analysis of these benefits involved the delineation in furthur detail of the changes in recreational potential as a result of the project. Knowing what is there now and how the project will affect it in the future is a major step towards providing a quantitative measurement of the benefit, whether in numerical or dollar form. The evaluations were provided through four major avenues. These were the Parks Planning Branch and the Fish and Wildlife Division of the Alberta Department of Lands and Forests, the Water Resources Division of the Alberta Department of Agriculture and a Survey of Recreation Use at Four Central Alberta Lakes carried out by this Division. Summaries of comments and data appear throughout this analysis. The discussion of benefits appears in narrative form except for Buffalo Lake.

Clarification of the procedure used to evaluate shoreline around water bodies, will make data interpretation easier. The Canada Land Inventory has laid down these procedures in a Field Manual entitled The Land Capability Classification for Outdoor Recreation.[5/] Their classification is based on the various outdoor recreational activities which could be supported and the intensity of use that can be carried out on any land unit. Land units divided on the basis of potential use are classed from 1 to 7. Class 1 denotes capability for the generation of a very high quantity of recreation on a sustained basis. Class 7 denotes capability by the land unit to generate a very low quantity of recreation. In order from Class 2 to Class 6, the capabilities are described as high, moderately high, moderate, moderately low and low. Location in relation to population and access are generally disregarded by the classification system.

---

[5/] Department of Forestry and Rural Development, Ottawa 1967.

## Evaluation of Benefits

### The Ardley Damsite

The key that turns the lock on the production of recreational benefits from the dam and reservoir is made up of two important factors: the absence of trees within the newly created reservoir and the uses to which the dam is put. Without tree clearance and without stable water levels there will be no recreational potential. To emphasize the importance of this point, the following quotation is taken from the Parks Planning Branch's evaluation. [6/]

> "A large water level fluctuation will occur primarily in the recreational season, May to September. This will preclude the use of the reservoir for cottaging and camping due to the difficulty of boat access to the water from developed areas above the high water level. Dock and boat launch facilities are impossible to construct with such water level fluctuation. Access in fact to the water is treacherous on steep muddy slopes and unpleasant over extensive mud flats, many of which would be created by fluctuating water levels. The aesthetics of such a situation are extremely poor and will not attract users."

With these two factors incorporated into the development, the recreational potential of this site would be similar to the average shoreland unit in Alberta. Activities that the reservoir would support include angling, boating, swimming, family bathing, paddling, camping, picnicking and water skiing.

According to the recreation classification there would be about 7 miles of Class 3 shoreline suitable for beach and cottage development, 8 miles of Class 3 shoreline suitable only for cottage development and 16 miles of shoreline of Class 4 again suitable only for cottage development. In contrast, Buffalo, Gull and Sylvan Lakes in the immediate area have Class 1 and Class 2 shorelines suitable for beach and cottage development. [7/]

---

[6/] Munn, Op. Cit.

[7/] Data on shorelines for these lakes are presented in Table 2 on page 7.

The fishing potential for the Ardley dam is forecast as sport fishing rather than commercial fishing. [8/] Within the reservoir in early stages of development rainbow trout could be stocked for several years until native species such as pike, walleye, goldeye and sauger replaced them. The trout would yield 55 lbs. an acre or 7470 x 55 equals 410,850 lbs. annually. The expected yield for native species would be 10 lbs. per acre or 74,700 lbs. annually. If the reservoir outlets were designed so that cold lower layers of water could be released into the Red Deer River, a large stream trout fishery might be a possibility for several miles below the dam.

At this point some general comments might be useful. The urban population within a one hundred and fifty mile radius or a drive of three hours one way, approximates one million people. As natural bodies of water within this area become conjested, users will increasingly look for new possibilities especially if future growth achieves the proportions of the past ten to twenty years. It is likely that fishing would precede beach and cottage development as an activity at the site as the requirements are less rigorous. On a national average 10% of the population hold fishing licences. [9/] Thus there would be a potential market of 100,000 fishermen to draw from within the 150 mile radius of the dam. In quoting such a figure, the existence of many other fishing areas within Alberta which would compete for fishermen, must be remembered. As well, more than 60 percent of all sportsmen fished within a 100 mile radius of their homes in 1961. [10/]

---

[8/] Paetz, M.J., Memo on Fishing Potential sent to the Water Resources Division, Dept. of Lands and Forests, 1968.

[9/] "Fishing and Hunting in Canada", The Canadian Wildlife Service, Ottawa, 1961.

[10/] Ibid.

## Buffalo Lake

Buffalo Lake has an excellent shoreline for water based activities associated with good beach and cottage development. Table 2 shows Buffalo's merits for recreational potential and provides a comparison with other lakes in the area.

### TABLE 2

### RECREATIONAL POTENTIAL OF FOUR CENTRAL ALBERTA LAKES [11/]

| Class of Shoreline | Buffalo miles | Gull miles | Sylvan miles | Pigeon miles |
|---|---|---|---|---|
| 1 | 1.2 | --- | --- | 1.6 |
| 2 | 4.2 | 2.5 | 2.3 | 3.9 |
| 3 | 17.8 | 7.2 | 3.8 | 17.4 |
| 4 | 49.4 | 14.6 | 13.1 | 3.7 |
| 5 | 0.7 | 7.9 | 2.0 | 0.2 |
| 6 | --- | --- | --- | 0.5 |
| 7 | --- | --- | --- | --- |
| Total Miles | 73.3 | 32.2 | 21.2 | 27.3 |

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

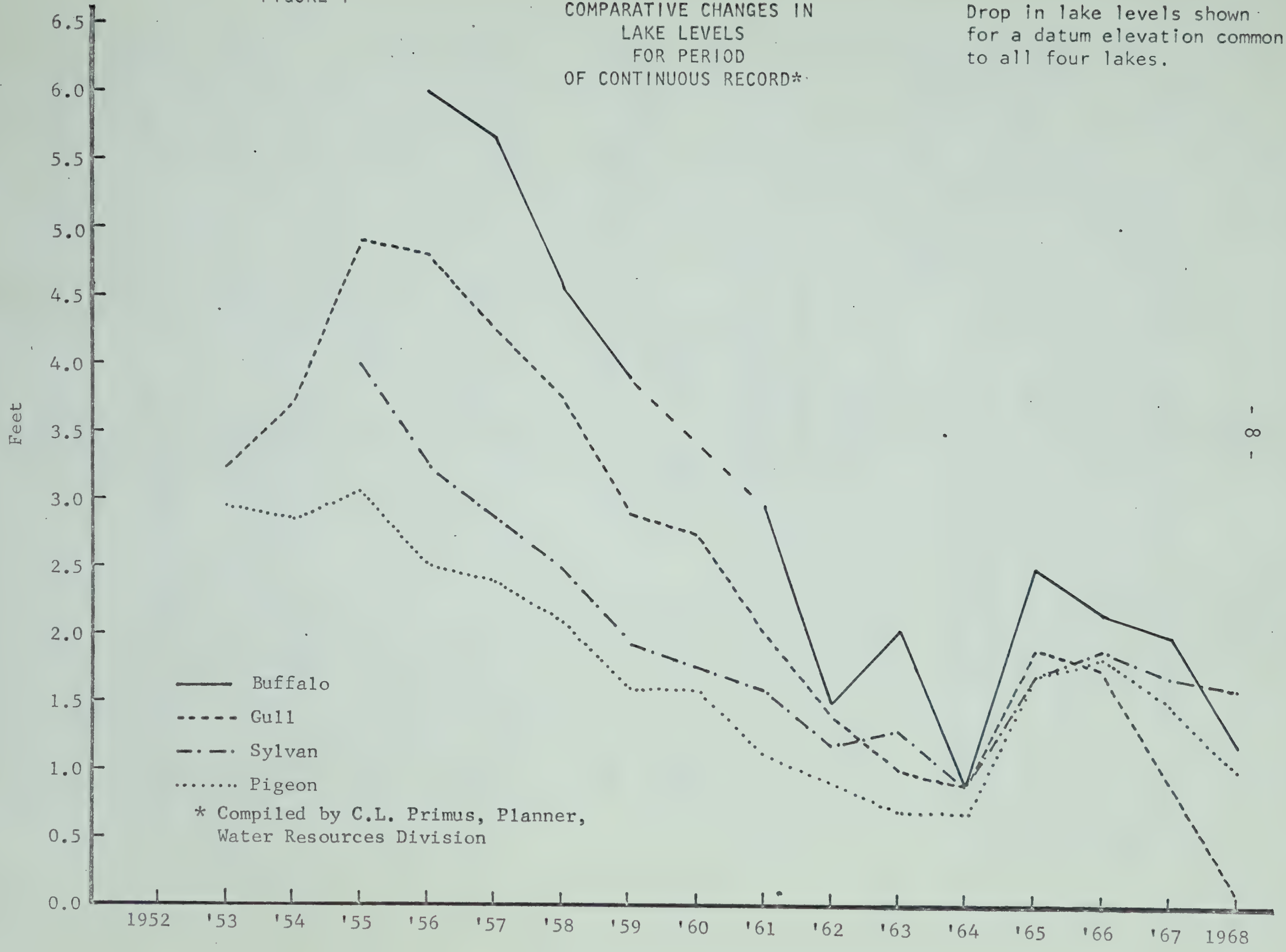
This classification does not include in its assessment three important factors which must be evaluated when considering potential. These are fluctuating water levels and their effect on the outward or inward movement of water from or to the established shoreline; present access to the shoreline; and the market area from which the lake can draw recreationists.

The water level on Buffalo has varied significantly over the last fifteen years. Generally there has been a downward trend as shown in Figure 1 on page 8 which compares Buffalo's water level to Gull, Sylvan and Pigeon.

---

[11/] Unpublished data for internal use only, Parks Planning Branch, Department of Lands and Forests, 1968.

FIGURE 1



COMPARATIVE CHANGES IN
LAKE LEVELS
FOR PERIOD
OF CONTINUOUS RECORD*

Drop in lake levels shown for a datum elevation common to all four lakes.

* Compiled by C.L. Primus, Planner,
Water Resources Division

Figure 1 indicates that fluctuations in the water levels of the four lakes are in response to common climatic conditions. Over a given period of time fluctuations are greater at Buffalo and Gull than at Sylvan and Pigeon. Table 3 points out how far the water line will recede from the established shoreline if the water level dropped five feet. The points chosen are areas of intensive use. They are Rochon Sands Provincial Park at Buffalo, Aspen Beach at Gull, the town of Sylvan Lake at Sylvan and Mam-e-o Beach at Pigeon.

## TABLE 3

## OUTWARD MOVEMENT OF WATER FOR FOUR CENTRAL ALBERTA LAKES[12/]

| | Rochon Sands ft. | Aspen Beach ft. | Sylvan Lake ft. | Mam-e-o Beach ft. |
|---|---|---|---|---|
| Distance outward for first 5 foot drop in water level | 1900 | 1500 | 700 | 400 |

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

"A combination of these two factors, greater fluctuations in water level, and flatter bottom gradients would contribute to poorer beach conditions at Buffalo and Gull." [13/] The project could stabilize Buffalo's water level. Herein lies the key to recreational benefits attributable to the project. A further comment to emphasize this point is contributed by the Parks Planning Branch.[14/]

"The diversion of water through Buffalo Lake with a possible rise in lake level, the stabilization of the lake level and the improved water quality could make Buffalo Lake a very high class summer recreation area."

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[12/] Primus, C.L., Planner , Water Resources Division, Edmonton 1968.

[13/] Ibid.

[14/] Munn, Op. Cit.

Access to the lake may hinder development and local road systems and private land ownership may reduce the area available for recreational use. The map on page 11 shows the existing road system around Buffalo Lake. The roads within the County of Camrose are not differentiated between gravelled and unimproved surfaces. There is only one paved road to the lake and very little access along the shoreline. Most of the lands are privately owned.[15/] These factors would tend to inhibit use.

The market determined by the size of the population within easy driving distance of the lake will indicate whether the lake will be used to its maximum potential. Table 4 shows the total population for 1966 and 1981 that can use this resource within expanding road-mile distance zones from Rochon Sands. Urban population is defined here as centres which have more than 250 people.

TABLE 4

URBAN POPULATION BY DISTANCE ZONES
FOR BUFFALO LAKE [16/]

| Distance Zone road miles | 1966 Population | 1966 % of Total | 1981 Population | 1981 % of Total |
|---|---|---|---|---|
| 0 - 25 | 5,328 | 0.6 | 5,945 | 0.4 |
| 26 - 50 | 5,408 | 0.6 | 5,931 | 0.4 |
| 51 - 75 | 47,439 | 5.4 | 74,237 | 5.4 |
| 76 - 100 | 21,011 | 2.4 | 27,548 | 2.0 |
| 101 - 125 | 408,517 | 46.6 | 671,072 | 48.8 |
| 126 - 150 | 21,408 | 2.5 | 40,071 | 2.9 |
| 151 - 175 | 345,051 | 39.4 | 524,166 | 38.1 |
| 176 - 200 | 21,726 | 2.5 | 27,155 | 2.0 |

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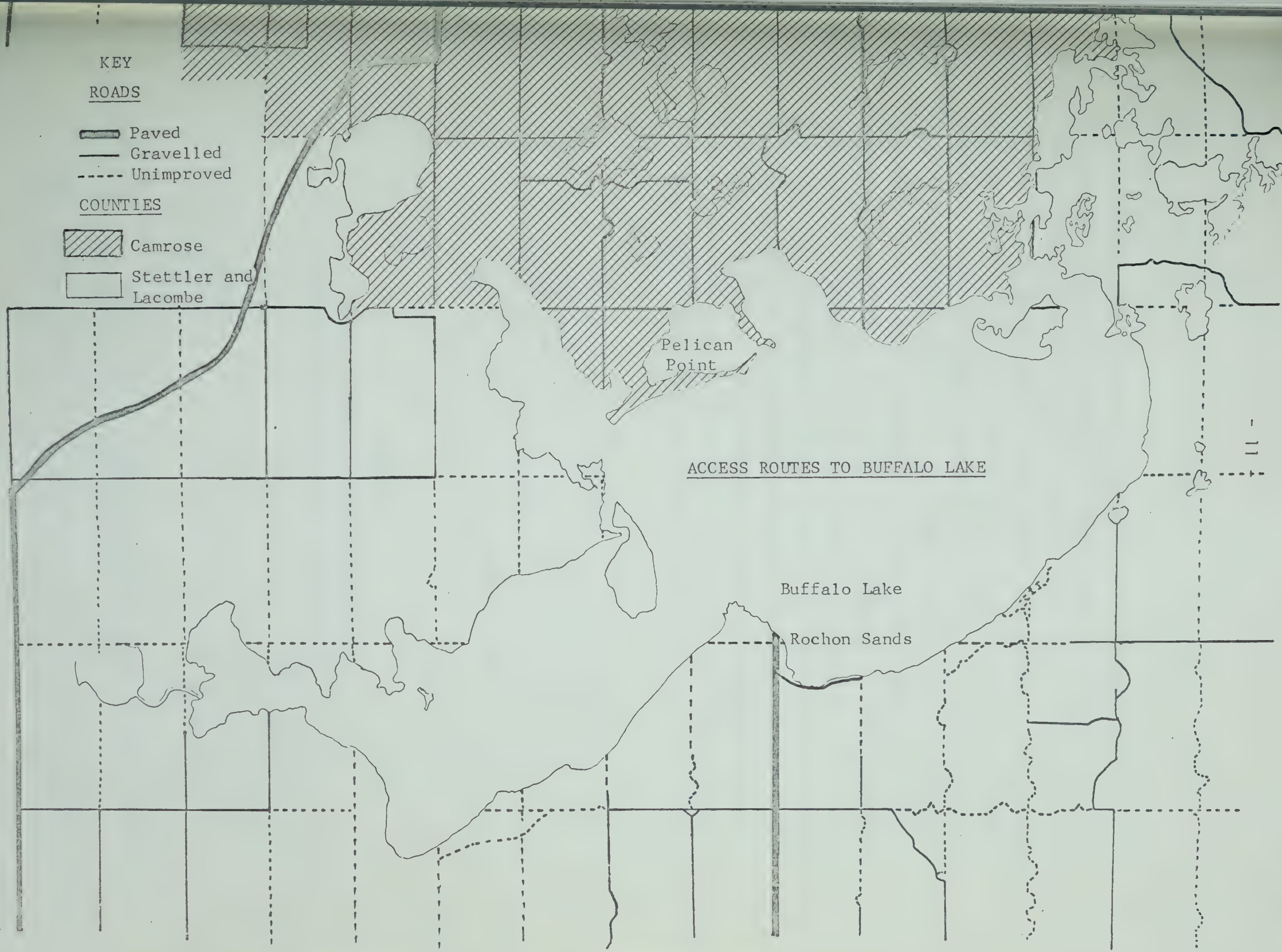
[15/] County of Stettler, Camrose and Lacombe Land Ownership Maps.

[16/] Dant - Noel, Population 1 & 2 - Trends and Density, Provincial Planning Branch, Department of Municipal Affairs 1967.



ACCESS ROUTES TO BUFFALO LAKE

These population figures include the cities of Red Deer in the 51 - 75 mile zone, Edmonton in the 101 - 125 mile zone and Calgary in the 151 - 175 mile zone. The focal point for road mileage calculations is the Provincial Park at Rochon Sands. These figures indicate a general potential but must be qualified by the proportion of the population which are interested in water based outdoor recreational activities. A survey of Edmontonians found that 17.4% of the trips made by people on a single day or weekends , were made to satisfy the interests of swimming, boating or going to the cottage. 17/ As well, three-quarters of the day trips were made within a radius of fifty miles of Edmonton. Weekend trips were generally made to points more than one hundred miles from Edmonton. 20.9% of all weekend trips were made to lakes which closely corresponds to interests expressed as a reason for taking the trip. Considering these facts, the expected proportion of the total population within a 200 mile zone from Rochon Sands that would attend Buffalo Lake would be significantly lower than the total figure.

A comparison of the use being made of Buffalo at present with other lakes in Central Alberta would indicate the potential for furthur development if the lake level was stabilized. Aspen Beach Provincial Park at Gull Lake had an attendance of 516,620 user days in 1967. This was five times the attendance at Rochon Sands at Buffalo. The density of cottage development at the lakes expressed in cottages per mile of potential cottage shoreland is shown in Table 5.

TABLE 5

DENSITY OF COTTAGE DEVELOPMENT PER MILE OF SHORELINE SUITABLE FOR COTTAGE SITES 18/

| Lake | Number of Cottages per mile |
|---|---|
| Buffalo | 6.9 |
| Gull | 16.7 |
| Sylvan | 26.9 |
| Pigeon | 48.9 |

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17/ Rigby, D., Travel Patterns of Edmontonians, Master's Thesis, Dept. of Geography, University of Alberta Edmonton, 1966.

18/ Computed from recreation classifications supplied by Parks Planning Branch Alberta Dept. of Lands and Forests and data supplied by Secretary-Treasurers of local administrations who have cottage developments.

Buffalo is comparatively undeveloped. These densities include cottages on non frontage as well as frontage lots.

Before assuming that Buffalo could duplicate conditions at the other lakes, the populations within distance zones from the lakes must be examined. Table 6 shows that Buffalo must draw people from farther away than do Gull and Sylvan. Pigeon has a definite advantage in being closer to Edmonton.

TABLE 6

PROPORTIONS OF THE 1966 URBAN POPULATION
WITHIN EXPANDING DISTANCE ZONES
FROM FOUR CENTRAL ALBERTA LAKES [19/]

| Distance Zone | Cumulative % of Total Population | | | |
|---|---|---|---|---|
| | Buffalo | Gull | Sylvan | Pigeon |
| Within 25 miles | 0.6 | 3.8 | 4.0 | 0.1 |
| " 50 " | 1.2 | 5.5 | 5.5 | 2.5 |
| " 75 " | 6.6 | 8.4 | 7.3 | 53.2 |
| " 100 " | 9.0 | 55.5 | 53.5 | 55.2 |
| " 125 " | 55.6 | 95.2 | 93.3 | 57.6 |
| " 150 " | 58.0 | 96.8 | 95.7 | 59.2 |
| " 175 " | 97.4 | 98.7 | 97.9 | 98.3 |
| " 200 " | 99.9 | 99.9 | 99.9 | 100.0 |
| Total Population | 875,888 | 877,456 | 895,152 | 883,320 |

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On the basis of this evidence, Buffalo is at present relatively undeveloped compared to the other lakes in the area because of fluctuating water levels and the consequent variation in distance from water to the established shoreline. As well, although not as important, limited access to the shoreline on good roads and the distance of the site from major

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[19/] Dant N, "Population - 2 - Density" Provincial Planning Branch, Dept. of Municipal Affairs, Edmonton 1967.

centres of population hinder development. Stabilization of the lake level would go a long way towards increasing the use of this recreational resource. By doing so and providing a complementary investment in roads, parks and cottages, attendance should increase to more closely approximate present use at Gull and Sylvan Lakes during the life of the project. This is especially so if the population projections for urban centres within a 200 mile radius of Buffalo becomes a reality. By 1981 the total population within this area is projected at 1,376,125.[20/]

To evaluate recreation benefits which accrue to users of Buffalo Lake requires data on the prices that would be paid for this resource and the quantities they would consume. In Alberta, public use of recreational water resources is not priced to date. Cottage owners on the other hand do purchase lots which provides them with a private location next to the lake. Values for lake frontage lots should reflect the value of having direct access to the water level, when compared to non frontage lots. Table 7 indicates these differences.

TABLE 7

VARIATION IN LOT VALUES
AT FOUR CENTRAL ALBERTA LAKES [21/]
(Average $ per lot)

| | Buffalo | Gull | Sylvan | Pigeon |
|---|---|---|---|---|
| | $ | $ | $ | $ |
| Frontage | 538 | 1414 | 2995 | 2635 |
| Non-Frontage | 75 | 1008 | 1520 | 1030 |
| Difference | 463 | 406 | 1475 | 1605 |

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Sylvan and Pigeon, which have the least change in water line to shore, have the highest differential between frontage and non frontage lots. The differential at Gull and Buffalo reflects the greater outward movement of

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[20/] Dant, W., Population - 1 - Trends, Provincial Planning Branch, Dept. of Municipal Affairs 1967.

[21/] Parlby, G.B., Recreational Characteristics of Four Central Alberta Lakes, Unpublished Report, Economics Division, July 1968.

water from the shore. While the influence of location and services has not been separated out for this analysis, the differential in lot values is attributed to water level problems. The difference between differentials at Sylvan or Pigeon and Buffalo or Gull approximates $1000.00.

Assuming 100 foot lot frontages or about 50 cottages per mile, the potential for development at Buffalo with a stabilized lake level would approximate 1850 cottages. There are 37 miles of lake shore suitable for development. If it is assumed that this potential will be realized over the life of the project, on average 37 cottages would be constructed each year. A net direct annual benefit of $37,000 would accrue to the project. As well, although not measurable in $ value at present, the attendance at parks might increase from 105,097 user days in 1967 to around 500,000 user days over the life of the project.

## Wildlife

Attempts were made to quantify the changes in wildlife numbers because of the project. Without extensive research these quantities are at present unmeasurable. As a result no economic surveys were conducted on the value of wildlife to the hunter by this Division. Thus the benefit of the project is at present unmeasurable. Within the framework of this report the most that can be done is to verify and establish to a greater extent the existence of benefits to wildlife from the project.

S. Arnell, Geographer, with the Development Planning Branch of the Water Resources Division has indicated the possible effects of the project on ducks within the distribution area.[22/]

> Prairie potholes are recognized as "the backbone of duck population in North America". (Waterfowl Tomorrow P.39) "Given a few wet years, the prairie country can pyramid duck numbers to a startling proportion. Several successive drought years bring an inevitable crash. Populations dwindle almost in direct proportion to the decline in water." (Waterfowl Tomorrow P.39)

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[22/] Memo from S. Arnell to G.B. Parlby, December 8, 1967.

"The prairie pothole region makes up only 10 per cent of the total waterfowl breeding area of this continent yet it produces 50 per cent of the duck crop in an average year - more than that in bumper years." (Waterfowl Tomorrow P.39)

Snow melt is the major source of runoff for prairie potholes. Isolated heavy rains may also fill them. Other factors such as amount of soil moisture in the fall affecting the depth of freezing over the winter and thus the amount of runoff likely to occur from snow melt, determine the volume of water in the potholes from year to year.

Crissey claims that changes in the proportion of birds nesting in the prairie potholes is caused by the amount and pattern of precipitation, which materially increases and decreases the number of potholes. (Crissey - 1967 P. 2) He goes on to say that "although there is a highly significant relationship between the number of potholes in one year and the size of duck breeding population the following spring, it appears that the strength of this relationship has been reduced by purposeful management manipulations, and the effect of weather during nesting and brood periods." (Crissey - 1967 P.3)

In a study of the reaction of wild fowl to a drying trend, Crissey discovered that mallard and canvas back populations continued to increase despite the trend while pintails, blue-winged teal and redheads decreased. He attributed this to the fact that the former tend to nest in parkland potholes where moisture conditions are more stable and early spring conditions are better, while the latter prefer grassland potholes which show immediately the reduction in precipitation. (Crissey - 1967 P. 3-4) From this theory he formulated a theory that "... the number of mallards produced in a given year is more a function of the number of July ponds than it is the size of the breeding population during that year". (Crissey - 1967 P. 4-5)

The implications of this theory for waterfowl hunting in North America are considerable. By increasing the availability of potholes to breeding ducks, a continued and perhaps increased harvest for the sportsmen can be assured. Potholes can be made available through programs now in existence to discourage farmers from draining productive waterbodies and to develop ephemeral potholes into more or less permanent ones. Another means of preserving potholes for use by breeding ducks is to export waste water or to provide water specifically to control the levels in potholes.

Under the proposed Red Deer River diversion scheme improvement of waterfowl habitat could be a significant benefit. The reservoirs themselves should provide assured breeding grounds for some species of ducks. Canvas backs in particular were noted to increase in the Brooks area after the establishment of the irrigation district there. (Salt-Wilk P.67) Other species now being driven north to breed by a progressive reduction in suitable prairie habitat might be expected to take advantage of the creation of large reservoirs. The Lesser Scaup, which favours larger lakes as breeding areas might be drawn to reservoirs on the Red Deer River as they have elsewhere.

As important as the creation of reservoirs would be for the production of waterfowl for the hunter, the preservation and extension of potholes must not be overlooked. Ducks require the number, and variety of many potholes to provide isolation at the beginning of the breeding season, escape cover for broods, loafing places for adult and young, and the necessary plant and animal foods." (Waterfowl Tomorrow P. 44-45) "Not that one pond cannot fulfill all waterfowl requirements ... but a combination of the two environments, lake and pothole, would best ensure optimum yields from annual waterfowl breeding." (Waterfowl Tomorrow P. 45)

Under the Red Deer River diversion scheme an arrangement whereby waste water or other water could be made available for spreading into potholes when levels are below the optimum should certainly be considered as a necessary benefit to waterfowl which depend upon breeding grounds in the area for their very survival, and to hunters who annually gain enjoyment and add to the economy through their sport.

References:

1. Crissey, Walter F. 1967. Prairie Potholes From A Continental Viewpoint. Migratory Bird Populations Station Bureau of Sport Fisheries and Wildlife, Laurel, Maryland, February 21, 1967, Manuscript 14 pp.

2. Gollop, J.B. 1965. Wetland Inventories in Western Canada. International Union of Game Biologists. Transactions of the VIth Congress, 7 October to 12 October, 1963, Bournemouth, London, The Nature Conservancy.

3. Salt, W. Ray and Wilk, A.L. 1966, The Birds of Alberta. 2nd ed. Government of Alberta, Department of Industry and Development.

4. United States, Department of the Interior, 1964. Waterfowl Tomorrow. Joseph P. Linduska ed., Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Washington.

# Section II

## FLOOD PROTECTION

### The Area

Floods have occurred periodically over the years along the tributaries and on the Red Deer River proper. The particular section of the river which is pertinent to this report is the valley of the Red Deer south of the proposed Ardley dam. The high banks along the Red Deer contain flooding to the immediate area at their base referred to as the river flats. Consequently, agricultural areas subject to damage are limited. Urban centres located on the flats are of prime concern. These include the City of Drumheller and associated hamlets within Improvement District #42. These hamlets grew up with development of the coal mines in the Drumheller area, prior to the discovery of other fuels such as natural gas and oil. They include Nacmine, Midlandvale, Rosedale, Cambria, Le High, East Coulee and Western Monarch. Table 8 shows the respective populations for 1956 and 1961 for all centres larger than 50 persons.

TABLE 8

POPULATIONS OF CENTRES WITHIN IMPROVEMENT DISTRICT #42 [23/]

1956 and 1961

| | 1956 | 1961 | Change |
|---|---|---|---|
| Drumheller * | 2,632 | 2,931 | + 299 |
| North Drumheller * | 344 | 429 | + 85 |
| Newcastle * | 1,132 | 949 | - 183 |
| Midlandvale * | 538 | 449 | - 89 |
| Nacmine | 371 | 285 | - 86 |
| Rosedale | 384 | 301 | - 83 |
| Cambria | 130 | 80 | - 50 |
| East Coulee | 1,003 | 683 | - 320 |
| Western Monarch | 189 | 153 | - 36 |
| Total | 6,723 | 6,260 | - 463 |

* Populations of centres within the survey area. Drumheller annexed North Drumheller and Newcastle in 1967. Total 1961 population within the survey area is 4,758 or 76% of the total.

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[23/] Dominion Bureau of Statistics, Census of Canada, Department of Municipal Affairs, Alberta - Population Statistics.

## The Hypothesis

A dam at Ardley would provide some measure of protection against flooding at Drumheller. To the extent that peak discharges are contained and as a consequence damages are reduced, benefits occur to the project.

## The Procedure

Data on frequency, discharge and stage relationships for flows on the Red Deer River were made available by the Hydrology Branch of the Water Resources Division. [24/] A five foot contour map was available for the survey area from the Provincial Planning Branch of the Alberta Department of Municipal Affairs. By relating intantaneous discharge, probability of occurance, and geodetic survey of Canada contour data, the areas that would be flooded for three levels of flooding were determined. The elevations selected were 2,235, 2,240 and 2,245 feet. Assessment values on buildings and improvements within these cross-sections were obtained for the City of Drumheller and for Midlandvale. [25/]

The last severe flood which caused a great deal of damage occurred in 1948. No central record of damages exists. Experience has suggested that the time interval between 1948 and 1968 is too long to develop any predictable damage relationships by direct survey techniques. [26/] Another avenue was sought. The Royal Commission on Flood Cost-Benefit which was concerned with urban damages on the Assiniboine and Red rivers in Manitoba developed data on damages correlated with assessments for various flood stages. For analysis, this data has been superimposed upon the Drumheller situation. A frequency-damage curve was prepared. The net direct benefits were estimated for various levels of control which might be adopted.

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[24/] Holecek, Flooding Action on the Red Deer River in Drumheller, Unpublished Report, Hydrology Branch, Water Resources Division, January 1968.

[25/] Guidolin, D., City Manager, Drumheller, Alberta, Mrs. M. Collins, Secretary, Improvement District #42.

[26/] Parlby, G.B., Economic Flood Survey Bearberry Creek, 1967.

## Evaluation of Benefits

The benefits of flood protection arise through prevention of damages or by increases in the potential for industrial development on the flood plain. This analysis is concerned only with benefits arising from damage prevention. The areas affected to the 2,245 elevation are mainly residential.[27/] As such, present industrial activity and potential are generally unaffected by floods. It is assumed that there is no business loss or change in productivity as a result of flood control. The affected areas are presented in a map on page 21.

Benefits from damage prevention thus will be limited to savings in damages to residential and personal property. The first step in measuring these savings is to prepare a frequency damage curve under natural conditions. The next step is to prepare a similar curve under controlled conditions. To date engineering proposals are not sufficiently advanced to prepare the second curve. Decisions on whether flood control is adopted depend in part on the relative value of benefits between competing uses. If the value of recreation requiring a stable water level is greater than the flood benefit, then an "either/or" situation or a combination of both might be selected.

Table 9 on page 22 presents the initial information required for the preparation of a frequency-damage curve under natural conditions.

Although there are only three points, a free hand damage frequency curve was prepared and is presented in Figure 3 on page 23. The area under the curve represents the average annual damages under uncontrolled conditions for all floods of all frequencies. A hypothetical curve under controlled conditions is shown in broken form. Normally the shaded area would represent the savings in damages on an annual basis. In the absence of this curve assumptions of absolute control to a specific probability of occurence are made. The full area under the curve to a given probability is adopted as the overall annual measure of protection provided. The results are presented in Table 10. As the survey area represented only 76% of the total population living within the Red Deer Valley at Drumheller these estimates may be conservative.

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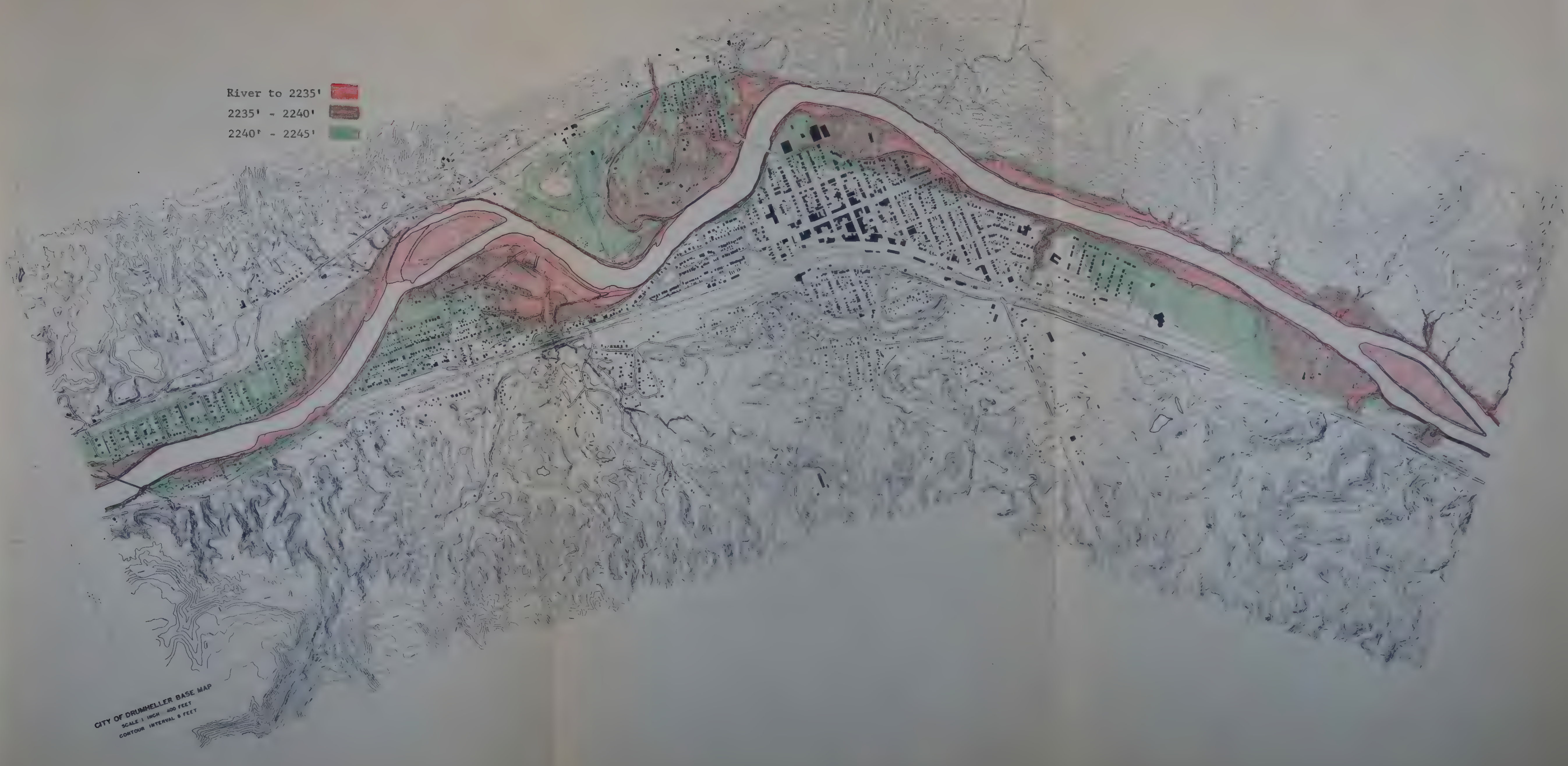
27/ Discussions with City Officials, Drumheller and correspondence with Railway Officials.


River to 2235' 🟥
2235' - 2240' 🟫
2240' - 2245' 🟩
CITY OF DRUMHELLER BASE MAP
SCALE 1 INCH 400 FEET
CONTOUR INTERVAL 5 FEET

## TABLE 9

## FREQUENCY - DAMAGE RELATIONSHIPS

### Drumheller

| G.S.C. Datum[28] (feet) | Probability of Occurence[29] | Assessed Value Buildings and Improvements[30] ($) | Comparable Winnipeg Assessment[31] ($) | Total Damages 1966 Dollars ($) |
|---|---|---|---|---|
| 2,235 | 0.1800 | 0 | 0 | 0 |
| 2,240 | 0.0350 | 333,810 | 358,512 | 330,070 |
| 2,245 | 0.0065 | 800,445 | 859,678 | 812,054 |

## TABLE 10

## AVERAGE ANNUAL DAMAGES

### Drumheller

| Complete Control of floods for: | Average Annual Damages |
|---|---|
| All Frequencies | $ 38,000 |
| Up to 1 in 100 | 28,000 |
| Up to 1 in 50 | 22,000 |
| Up to 1 in 25 | 14,000 |
| Up to 1 in 10 | 4,000 |

Any of these figures could be considered the net direct benefit to the project depending on the amount of protection provided.

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[28] Contour Map, City of Drumheller, Department of Municipal Affairs, Edmonton.

[29] Munn, Op. Cit. Data was used from Figure 4A. The propability of occurence was based on the stage reached by measurement of the instantaneous discharge of the river.

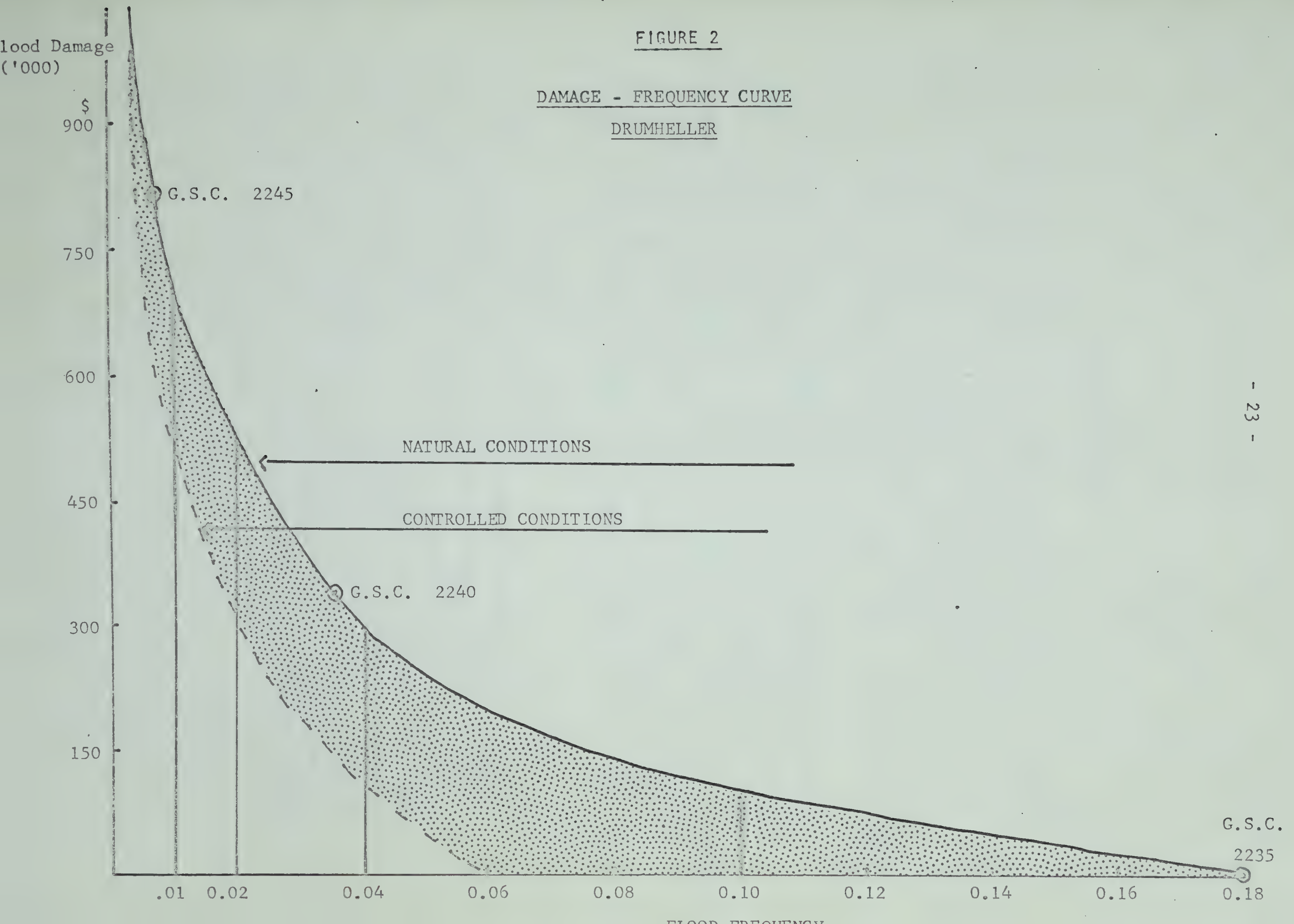
[30] Supplied by City of Drumheller and I.D. #42.

[31] Conversion factor 1.074. Correspondence with Assessment Commissioner, City of Winnipeg, 1968. The damages were calculated from assessment-damage formulae in the Royal Commission on Flood-Cost Benefit, Queen's Printer, Winnipeg, Manitoba 1958. An average depth of 3 ft. was assumed. A one-foot foundation was assumed as well. The damage data was converted to 1966 dollars by an inflator of 1.284 based on the General Wholesale Price Index for Non Farm Products. Damages include both personal and real property damages.

## FIGURE 2

DAMAGE - FREQUENCY CURVE

DRUMHELLER



# Section III

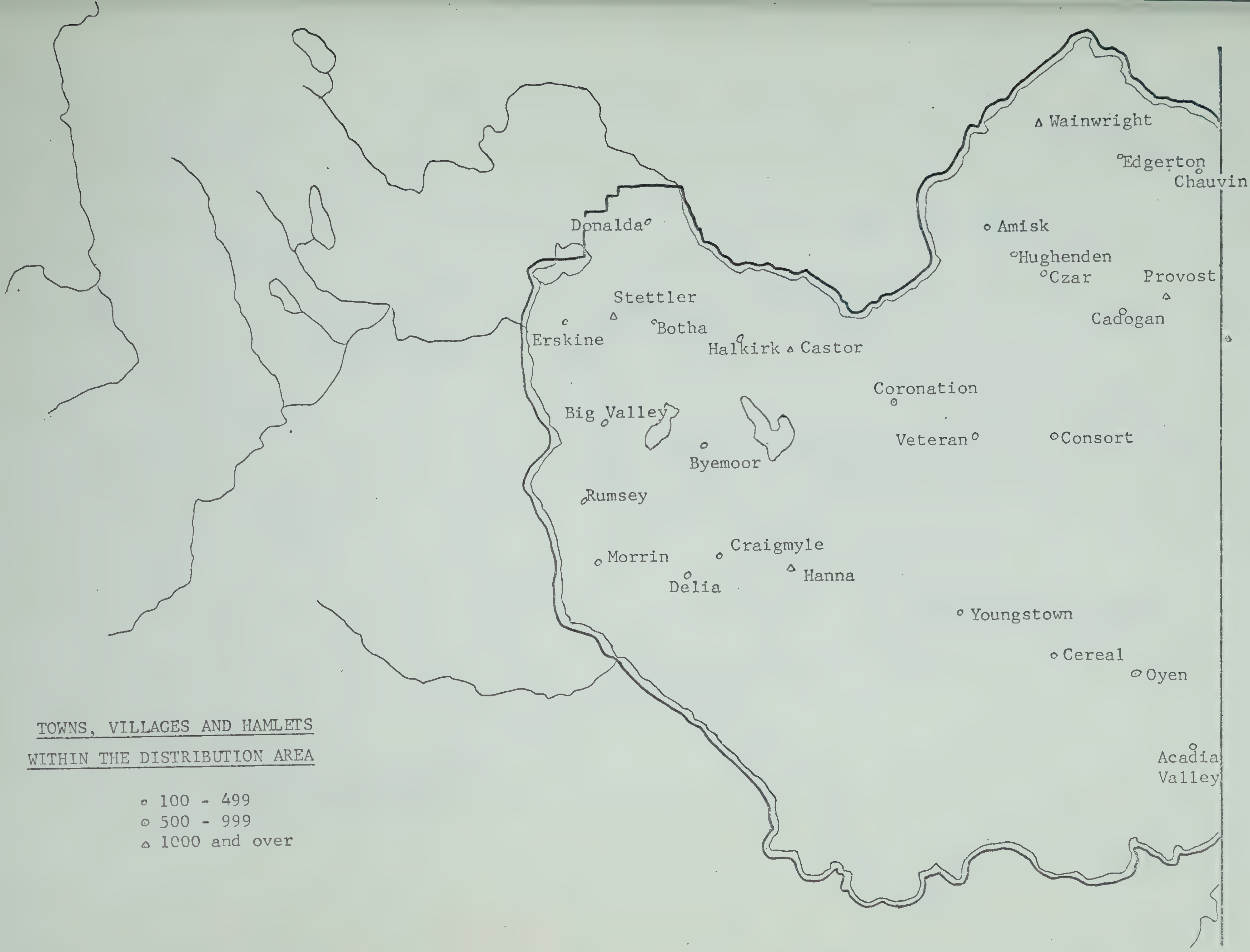
## DOMESTIC WATER

Domestic water is a consumer product which, for classification purposes, encompasses all uses of a personal nature. These include bodily consumption, cooking, bathing, laundring, car washing, sewage disposal and garden and lawn watering. The opposite criterion refers to all other uses where water is an input for the production of producer or consumer goods and services. The proposed benefits for domestic water are limited to water uses within the criterion of a consumer product.

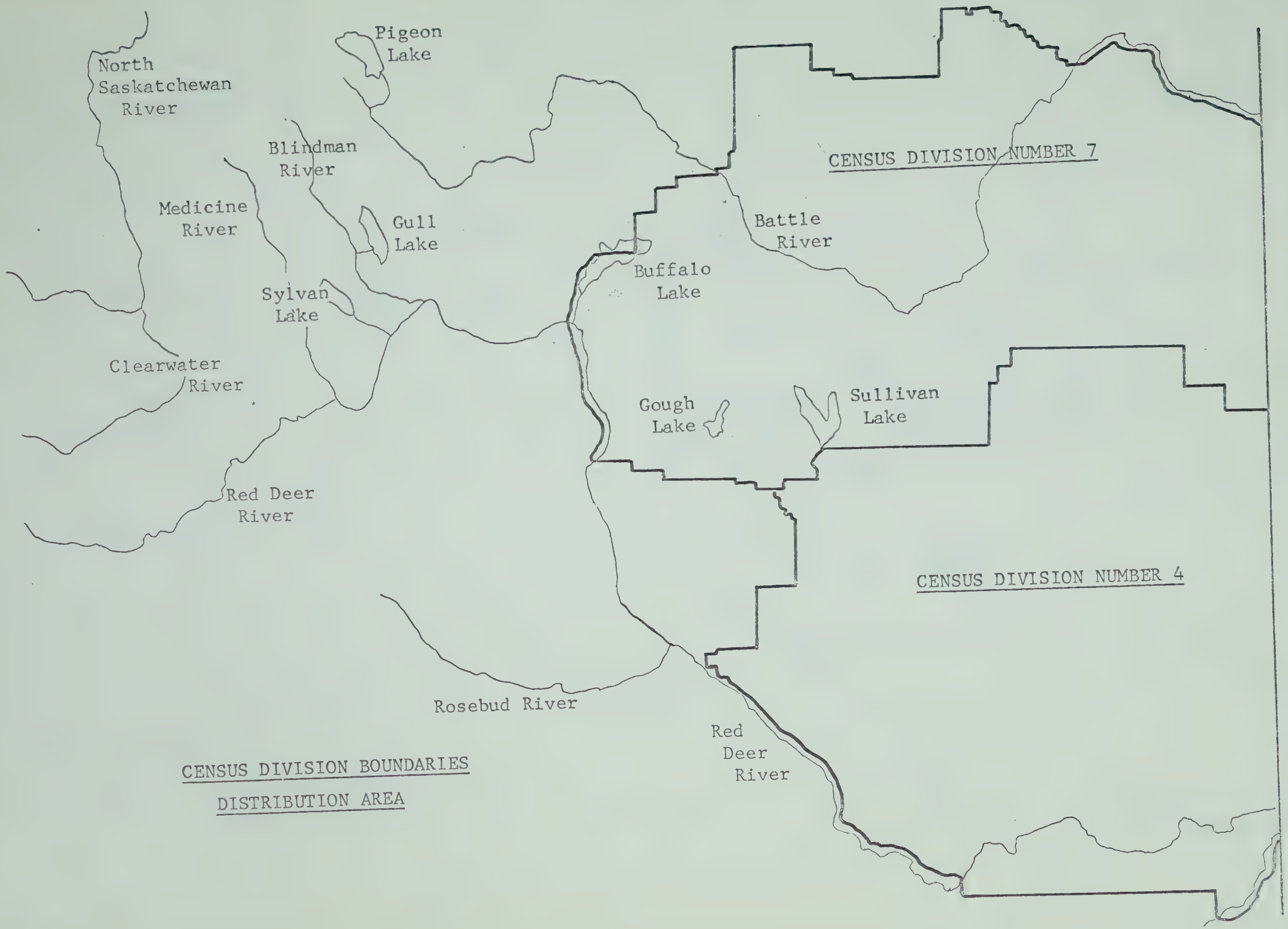
Provision of water for domestic use is one of individual or group action. Hence the individual on the farm, in a small subdivision or in a hamlet provides his own domestic water with his own resources. Where concentrated areas of population are found, the supply of domestic water is provided by municipal organizations. Where water is available from irrigation projects, individuals or groups may choose to tap this supply, but still have to provide their own storage, treatment, pumping and distribution facilities.

### The Area

Within the boundaries of the proposed distribution system there are seven towns, twenty villages, and seventeen hamlets with a population greater than fifty people. The rest of the population lives in smaller communities, or resides on farms and ranches and as such could be classed as rural. The maps on pages 25, 26, and 27 show the location of centres with a population greater than one hundred persons, the census areas, and the county boundaries within the distribution area. Table 11 shows the population of centres and of the whole area which is being considered for possible domestic water improvement.

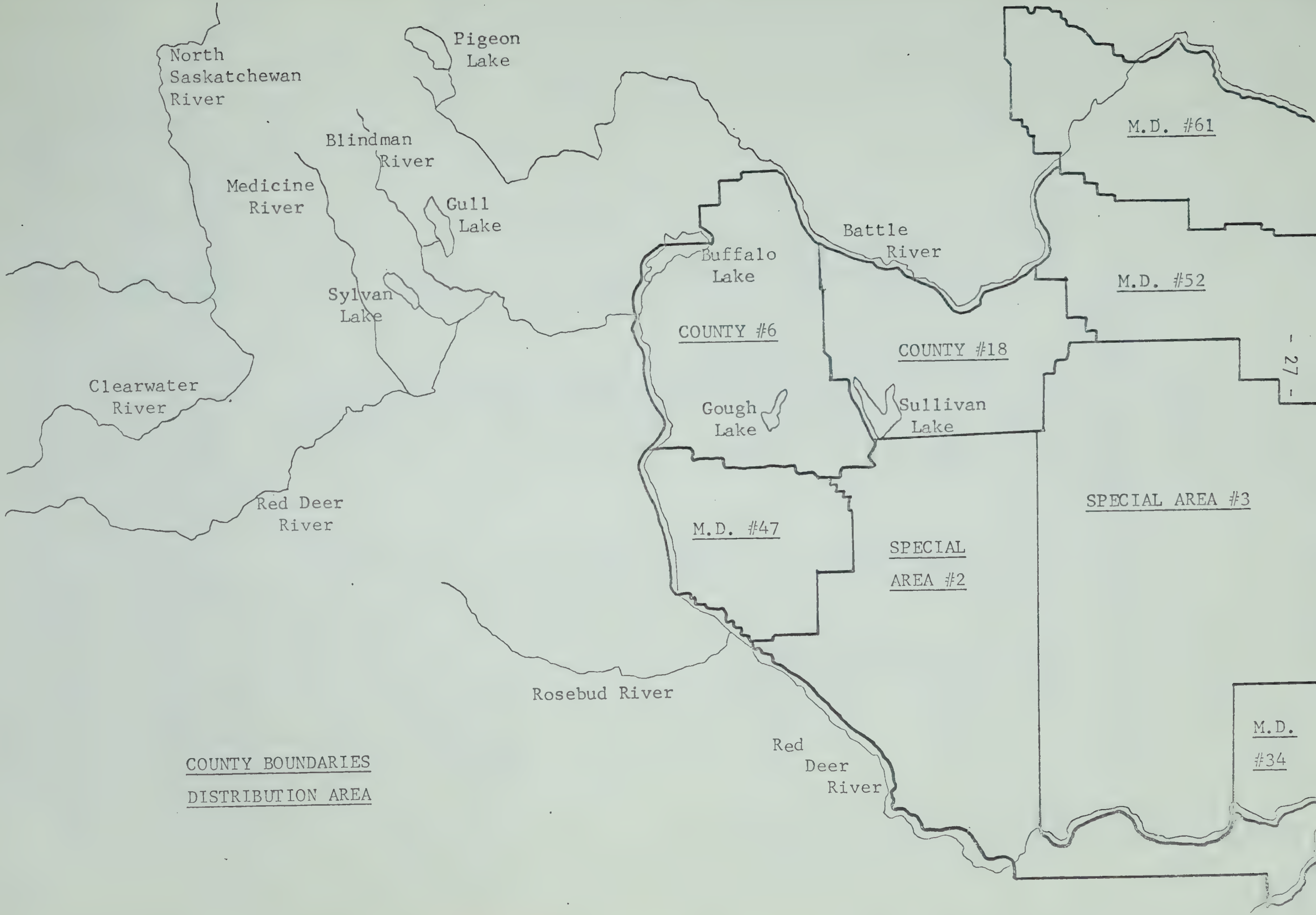


TOWNS, VILLAGES AND HAMLETS WITHIN THE DISTRIBUTION AREA



CENSUS DIVISION BOUNDARIES

DISTRIBUTION AREA



COUNTY BOUNDARIES

DISTRIBUTION AREA

## TABLE 11

## POPULATION USING DOMESTIC WATER IN THE DISTRIBUTION AREA[32]

| Hamlets | Pop. | Villages | Pop. | Towns | Pop. |
|---|---|---|---|---|---|
| Acadia Valley | 239 | Amisk | 134 | Castor | 1,090 |
| Altario | 72 | Big Valley | 378 | Coronation | 811 |
| Byemoor | 129 | Botha | 134 | Hanna | 2,633 |
| Cadogan | 109 | Cereal | 191 | Oyen | 846 |
| Compeer | 58 | Chauvin | 362 | Provost | 1,328 |
| Erskine | 208 | Chinook | 95 | Stettler | 3,988 |
| Fleet | 79 | Consort | 594 | Wainwright | 3,867 |
| Kirriemuir | 62 | Craigmyle | 98 | TOTAL | 14,563 |
| Hayter | 50 | Czar | 222 | | |
| Metiskow | 99 | Delia | 274 | | |
| Michichi | 52 | Donalda | 271 | | |
| Monitor | 86 | Edgerton | 345 | | |
| Red Willow | 95 | Gadsby | 84 | | |
| Ribstone | 68 | Halkirk | 177 | | |
| Rowley | 65 | Hughenden | 274 | TOTAL URBAN | 20,872 |
| Sibbald | 75 | Morrin | 272 | TOTAL RURAL | 26,048[33] |
| Sunnynook | 76 | Munson | 39 | TOTAL POP. | 46,920[34] |
| TOTAL | 1,622 | Rumsey | 108 | | |
| | | Veteran | 278 | | |
| | | Youngstown | 357 | | |
| | | TOTAL | 4,687 | | |

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[32] Census of Canada; Dominion Bureau of Statistics; Ottawa. Population Statistics; Department of Municipal Affairs, Edmonton, Alberta.

All populations for 1966, except those of unincorporated centres which are available only for 1961. These are assumed unchanged for 1966.

[33] Calculated as a residual from total population.

[34] Total Population, Census Divisions #4 adn #7 plus M.D. of Starland less the M.D. of Flagstaff excluding towns of Irma and Empress.

Present consumption levels provide an indication of the gross quantities required by this area under existing conditions. 1966 levels, where available, are shown in Table 12. The figures do not take into account availability of water, variations in prices charged, individual preferences, income differences or rationing of water where potential shortages exist.

### TABLE 12

### 1966 CONSUMPTION LEVELS FOR VARIOUS CENTRES IN THE DISTRIBUTION AREA [35]

| Town | Annual Consumption (gallons) | Consumption Per Capita Per Day (gallons) |
|---|---|---|
| Castor | 25,000,000 | 62.8 |
| Hanna | 63,575,000 | 66.2 |
| Provost | 25,000,000 | 48.8 |
| Stettler | 60,000,000 | 41.2 |
| Wainwright | 70,000,000 | 49.6 |
| Oyen | 12,775,000 | 41.4 |
| Village | | |
| Cereal | 3,679,200 | 52.8 |
| Chauvin | 18,000,000 | 136.2 |
| Consort | 5,403,200 | 24.9 |
| Delia | 3,500,000 | 32.1 |
| Donalda | 2,000,000 | 19.8 |
| Edgerton | 5,000,000 | 39.7 |
| Hughenden | 3,078,775 | 30.8 |

The weighted average consumption per capita per day for the centres outlined in Table 12 for 1966 is 50.6 gallons. The present annual consumption for the entire distribution area can be roughly estimated at 866 million gallons or 3,200 acre feet. [36] The annual requirement for

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[35] Interviews with Secretary-Treasurers of the respective towns and villages.

[36] 1 acre foot equals 271,542 gallons.

Census Division #4, which approximates the south half of the distribution area, can be estimated at 324 million gallons or 1,194 acre feet.

The sources of water and the manner in which they are provided are shown in Table 13.

TABLE 13

CHARACTERISTICS OF PRESENT WATER SUPPLY AND DISPOSAL SYSTEMS IN EAST CENTRAL ALBERTA [37/]

| Town | Source of Supply | Distribution System | Disposal System |
|---|---|---|---|
| Castor | surface | public | public |
| Coronation | ground | public | public |
| Hanna | surface | public | public |
| Provost | ground | public | public |
| Stettler | ground | public | public |
| Wainwright | ground | public | public |
| Oyen | ground | public | public |
| Village | | | |
| Amisk | ground | public | public |
| Big Valley | ground | public | public |
| Botha | ground | private | private |
| Cereal | ground | public | public |
| Chauvin | ground | public | public |
| Chinook | ground | private | private |
| Consort | surface | public | public |
| Craigmyle | ground | public | private |
| Czar | ground | private | private |
| Delia | ground | public | public |
| Donalda | ground | public | public |
| Edgerton | ground | public | public |

(continued)

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[37/] A Survey of Water and Sewage Systems in Alberta, Department of Public Health, Edmonton, and personal or mail interviews with Municipal authorities.

Continued from page 30

| Village | Source of Supply | Distribution System | Disposal System |
|---|---|---|---|
| Gadsby | ground | private | private |
| Halkirk | ground | private | public |
| Hughenden | surface | public | public |
| Morrin | ground | public | public |
| Rumsey | ground | public | private |
| Veteran | ground | private | public |
| Youngstown | ground | private | public |
| Hamlet | | | |
| Acadia Valley | ------- | ------- | ------- |
| Altario | ground | private | private |
| Byemoor | ground | private | private |
| Cadogan | ground | private | private |
| Compeer | ground | private | private |
| Erskine | ------- | ------- | ------- |
| Fleet | ground | private | private |
| Hayter | ground | private | private |
| Kirriemuir | ground | private | private |
| Metiskow | ground | private | private |
| Michichi | ------- | ------- | ------- |
| Monitor | ground | private | private |
| Red Willow | ------- | ------- | ------- |
| Ribstone | ground | private | private |
| Rowley | ------- | ------- | ------- |
| Sibbald | ground | private | private |
| Sunnynook | ground and surface | private | private |

The majority of urban centres within the distribution area obtain their domestic water from ground water sources. Surface supplies serve only a limited number of centres. Larger centres have public distribution and disposal systems, while smaller centres generally leave the development of water supply and sewage disposal to individual initiative.

Some light can be shed on the domestic supplies presently used by the rural population from a survey taken in areas #1 and #2 of the stock water survey.[38/] (See map on page 81.) The information is unlikely to be representative of the whole distribution area but could be projected to most of Census Division #4. In area #1, ground water was the sole source used to meet domestic requirements. Fifty-six percent of the residences in this area had a water-pressure and sewage system. Four and a half percent had only a pressure system and forty percent had neither. In area #2, ground water was the major source of supply and sixty-six percent of the respondents had a water and sewage system.

These statistics can be related to census data for Census Division #4 and #7. In 1961, 50.3% in Census Division #4 and 57.0% in Census Division #7 of the occupied dewllings had hot and cold running water. In 1961, 48.5% in Census Division #4 and 54.0% in Census Division #7 of the occupied dwellings had sewage facilities. [39/]

An indication of the adequacy of present supplies can be gained by noting any rationing which has taken place in recent years. Some price rationing exists wherever a block pricing policy is in effect. However, rationing here refers to restricting the quantity of water used by means other than price. Shortages as reported by municipal authorities are presented in Table 14. Four of the seven towns have experienced shortages of water; five of fifteen villages have experienced shortages; while no known shortages have been reported for hamlets. Most centres have turned to exploration and development of new ground water sources to overcome their difficulties. Shortages voiced here are expressed on present consumption levels and present price and cost relationships.

Water quality is of as much concern in the distribution area as is quantity. The geology of the area is such that many potential ground water supplies are negated because they do not meet the minimum requirements necessary to be classed as suitable for domestic use. Data available on water quality is limited to chemical water analyses made by the

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[38/] Results are based on a 25% sample of area #1 and a 50% sample of area #2.

[39/] Census of Canada, Dominion Bureau of Statistics, Ottawa, 1966.

## TABLE 14

### INDICATIONS OF RATIONING OF WATER IN URBAN CENTRES IN EAST-CENTRAL ALBERTA

| Town | No Rationing | Have Rationed | Years | Reason | Corrective Action |
|---|---|---|---|---|---|
| Castor | x | --- | --- | --- | --- |
| Coronation | x | --- | --- | --- | --- |
| Hanna | --- | x | 1962 | insufficient runoff | used alternate reservoir |
| Provost | --- | x | before 1967 | insufficient groundwater development | new wells |
| Stettler | --- | x | 1961 - 63 | insufficient groundwater development | new wells |
| Wainwright | x | --- | --- | --- | --- |
| Oyen | --- | x | 1960, 1963 | insufficient groundwater development | new wells |
| Villages | | | | | |
| Amisk | x | --- | --- | --- | --- |
| Big Valley | --- | x | all years | --- | --- |
| Cereal | x | --- | --- | --- | --- |
| Chauvin | x | --- | --- | --- | --- |
| Chinook | x | --- | --- | --- | --- |
| Consort | x | --- | --- | --- | --- |
| Craigmyle | --- | x | 1967 | --- | --- |
| Czar | x | --- | --- | --- | --- |
| Delia | x | --- | --- | --- | --- |
| Donalda | x | --- | --- | --- | --- |
| Edgerton | --- | x | 1960,1963 | insufficient groundwater supply | restricted lawn use.<br>new well |

Table 14 continued from page 33

| | No Rationing | Have Rationed | Years | Reason | Corrective Action |
|---|---|---|---|---|---|
| Gadsby | --- | --- | --- | --- | --- |
| Halkirk | --- | --- | --- | --- | --- |
| Hughenden | x | --- | --- | --- | --- |
| Morrin | --- | --- | --- | --- | --- |
| Munsen | Hauls waterfrom Drumheller on a regular basis, | | | | |
| Rumsey | x | --- | --- | --- | --- |
| Veteran | x | --- | --- | --- | --- |
| Youngstown | --- | x | always | poor groundwater supplies | exploration for wells. no success |
| Hamlets | | | | | |
| Acadia Valley | --- | --- | --- | --- | --- |
| Altario | x | --- | --- | --- | --- |
| Byemoor | --- | --- | --- | --- | --- |
| Cadogan | x | --- | --- | --- | --- |
| Compeer | x | --- | --- | --- | --- |
| Erskine | --- | --- | --- | --- | --- |
| Fleet | x | --- | --- | --- | --- |
| Hayter | x | --- | --- | --- | --- |
| Kirriemuir | x | --- | --- | --- | --- |
| Metiskow | x | --- | --- | --- | --- |
| Michichi | --- | --- | --- | --- | --- |
| Monitor | x | --- | --- | --- | --- |
| Red Willow | --- | --- | --- | --- | --- |
| Ribstone | x | --- | --- | --- | --- |
| Rowley | --- | --- | --- | --- | --- |
| Sibbald | x | --- | --- | --- | --- |
| Sunnynook | x | --- | --- | --- | --- |

Provincial Analyst. Table 15 shows the data for twenty-five urban centres in the distribution area.

A summary of the criteria used to determine suitability is as follows:[40/]

> "The quality of ground water has been found in general to be more important than its quantity. As greater development and use of ground water continues, combined with the re-use of water, quality suffers unless consideration is given to protect it.
>
> To establish quality criteria, measures of physical, chemical and bacterial constituents must be specified as well as standard methods for conducting and reporting the results of water analysis. Recommended limits of water quality criteria have been determined which serve as guides for proper protection and development of water basins."

Total solids refers to material left after the water has evaporated. Water is considered unfit for human consumption if it contains more than 4,000 p.p.m. of total solids. The total solids of good potable water should not exceed 500 p.p.m. based on taste thresholds. Anything over 1,000 p.p.m. must be judged on its own merits.

Hardness refers to the soap neutralizing power of a water. The higher the level of hardness the more inconvenient the use of the water becomes as more soap is used and utensils become encrusted. Normally a water with a hardness of 100 p.p.m. or less is most desirable.

Sulphates occur naturally in water. The recommended upper limit is 500 p.p.m. Beyond this point there can be a laxative action to new users. A cathartic dose is a liter of water containing 1,000 to 2,000 p.p.m.

Chlorides are found in most natural waters. Restrictions on chloride concentrations are generally based on palatability requirements rather than on health. 500 p.p.m. is considered to be an upper limit for chlorides.

Nitrites signify the possibility of pollution and should be tested further. In the minute amounts ordinarily found in drinking waters they can scarcely have a pharmacological effect.

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[40/] Briggs, R.N.; Chemical Analysis of Water; Environmental Health Division, Department of Public Health, Edmonton, Alberta, 1967. The following is a condensation of this paper.

TABLE 15

## CHEMICAL ANALYSIS OF WATER SUPPLIES FOR VARIOUS URBAN CENTRES IN THE DISTRIBUTION AREA

(parts per million)

| Centre | Total Solids | Hardness | Sulphates | Chlorides | Nitrites | Nitrates of Nitrogen | Iron | Fluorine | Remarks | Date |
|---|---|---|---|---|---|---|---|---|---|---|
| Suggested limits | 1,000 | 100 desirable | 500 | 500 | trace | 10 | 0.3 | 1.00 | | |
| Town | | | | | | | | | | |
| Castor | 430 | 200 | 94 | 33 | --- | --- | 1.20 | --- | A$^{-}$ | 1961 |
| Coronation | 1,304 | 20 | 340 | 34 | --- | --- | 1.45 | --- | A | 1967 |
| Hanna | 262 | 122 | 48 | 12 | trace | 2.2 | 0.05 | 0.20 | A | 1967 |
| Provost | 418 | 274 | 55 | 4 | trace | 3.5 | 0.32 | 0.30 | A | 1967 |
| Stettler | 940 | 25 | 134 | --- | --- | --- | --- | 1.20 | A | --- |
| Oyen | 546 | 311 | 148 | 6 | trace | 7.2 | 0.58 | 0.20 | A | 1967 |
| Wainwright | 952 | 20 | 196 | 8 | --- | --- | --- | 0.20 | A | 1967 |
| Village | | | | | | | | | | |
| Amisk | 868 | 100 | 149 | 2 | trace | 0.8 | 2.60 | --- | A | 1965 |
| Cereal | 1,606 | --- | 14 | 450 | --- | --- | --- | --- | B | 1965 |
| Chauvin | --- | --- | --- | --- | --- | --- | --- | --- | A$^{-}$ | 1967 |
| Chinook* | 2,924 | 1,000+ | 1,255 | 40 | --- | --- | 5.00 | 0.10 | B | --- |
| Consort | 1,192 | 110 | 375 | 78 | --- | --- | 4.00 | 0.41 | A$^{-}$ | 1967 |
| | 2,040 | 21 | nil | 990 | --- | --- | 0.59 | 1.00 | B | 1967 |
| Carigmyle | 2,850 | 529 | 1,140 | 62 | trace | 7.2 | 0.10 | 0.80 | B | 1967 |
| Delia | 1,790 | 134 | 469 | 10 | --- | --- | 0.37 | 1.00 | B | 1967 |
| Edgerton | 562 | 5 | 15 | 6 | --- | --- | 0.20 | 0.60 | A | 1967 |
| Hughenden | 844 | 8 | 117 | 8 | --- | --- | 0.35 | 1.20 | A | 1967 |
| Morrin | 1,220 | 138 | 195 | 20 | --- | --- | 0.36 | 0.30 | A | 1967 |
| Veteran* | 710 | 245 | 192 | 37 | trace | 0.3 | 2.00 | --- | A | --- |
| Youngstown* | 2,662 | 540 | 1,200 | 46 | trace | 0.9 | 2.80 | --- | B | 1966 |
| Hamlet | | | | | | | | | | |
| Altario* | 2,288 | 1,000+ | 918 | 32 | --- | --- | 2.70 | 0.20 | B | 1967 |
| Cadogen* | 1,104 | 13 | 259 | 8 | --- | --- | 0.25 | 1.10 | A | 1967 |
| Compeer* | 2,622 | 1,000+ | 1,127 | 40 | trace | 7.8 | 0.80 | 0.25 | B | 1967 |
| Metiskow* | 816 | 19 | 155 | 4 | --- | --- | 0.08 | 0.30 | A | 1967 |
| Sibbald* | 694 | 425 | 142 | 12 | --- | --- | 0.95 | 0.30 | A | 1967 |
| Sunnynook* | 1,134 | 21 | 44 | 240 | --- | --- | 0.55 | 0.14 | A | 1967 |

---

* Individual well tests; no public water system

A Suitable

B Unsuitable

A$^{-}$ Suitable after iron settles out

Nitrates An excess can cause irritation to the mucous linings of the gastrointestinal tract and bladder, with symptoms of diarrhoea and dirresia infant methemoglobinaemia. The accepted limit is 10 p.p.m. of Nitrate Nitrogen.

Iron may cause a build up of deposits in water distribution systems increasing frictional resistance in water lines, and water meters may become coated with iron oxides. Iron can alter the color and taste of certain foods and spoil the appearance of plumbing fixtures and cooking utensils by imparting a reddish stain on enamel. Clothing washed in iron bearing water often develops a yellow stain. Concentrations of more than 1 p.p.m. require treatment to remove the iron.

Table 15 indicates that the towns have suitable water quality supplies, at present. Water supplies of villages and hamlets vary in quality between suitable and unsuitable. In most cases, high salt concentrations are the cause of the water being unsuitable. Only three towns have a total solids content of less than 500 p.p.m., which would be considered good potable water as far as taste is concerned. Twelve centres have a total solids content of less than 1000 p.p.m. Fourteen of the twenty-five centres have water with a hardness value greater than the desirable limit of 100 p.p.m. Five centres have a sulphate content above the accepted limit.

Water quality on the basis of this information is of concern in a number of the centres in East Central Alberta. The information presented does not include the sources of water which have been explored and have been found to be unsuitable due to poor quality. To elaborate this point and to shed light on the probability of getting good potable ground water in this area, Table 16 is presented.

The chances of getting good potable water ranges from 1 in 10 to 1 in 20. The chances of getting water which meets the general limit of a 1000 p.p.m. total solids are approximately 1 in 2. Even then there is no guarantee that the well which meets quality criteria will have a large enough yield to meet the combined needs of the users it serves within acceptable cost limits.

## TABLE 16

## CLASSIFICATION OF GROUNDWATER WELLS BY TOTAL SOLIDS CONTENT [41]

| | Bedrock Groundwaters | | Drift Groundwaters | |
|---|---|---|---|---|
| | Number | % | Number | % |
| Number of wells | 380 | 100.0 | 252 | 100.0 |
| Range of Total Solids<br>p.p.m. | | | | |
| 0 - 499 | 19 | 5.0 | 30 | 11.9 |
| 500 - 999 | 137 | 36.0 | 73 | 29.0 |
| 1,000 - 1,999 | 182 | 48.0 | 98 | 38.9 |
| 2,000 and over | 42 | 11.0 | 51 | 20.2 |

### The Hypothesis

As demonstrated by the discussion on the present domestic use of water in the distribution area, there are problems in obtaining adequate supplies of suitable quality for domestic use. Water from the proposed distribution system would be an alternate source to present ground and local surface runoff water and as such would be a benefit from the project.

It is assumed for purposes of this analysis that the quality of water from the distribution system meets the standards of good potable water after treatment and that there are no limitations on the quantity required. It is assumed as well that water can be distributed to the total population of the area regardless of whether they are urban or rural and that engineering project cost estimates will include costs to all the areas and urban centres involved. The credibility of these assumptions might be questioned on the basis of common sense, as the population is sparsely spread over the area.

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[41] Le Breton, E.G. and A. Vanderberg, Chemical Analysis of Groundwater Supplies in East Central Alberta. Research Council of Alberta, Preliminary Report, Edmonton, 1965. Area involved is Townships 38 to 61 and Ranges 1 to 17 inclusive. This is mostly north of the distribution area but is comparable or better than the rest of the area.

However these assumptions must be made initially to prevent subjective judgments from entering the analysis.

## Procedure

There are two questions to be answered. What benefits will arise because of increases in quantities of water available for domestic use? Secondly, what benefits will arise from improvement of the quality of domestic water that is used?

To measure these benefits estimates are required on future population trends and per capita consumption levels within the distribution area. Next, an evaluation of the possible alternatives and their respective supply costs, assuming a standard quality and quantity of domestic water is required. The least costly alternative will be the most favourable source of supply in the eyes of the domestic user. The margin between the least cost alternative and the next best alternative will provide a measure of the net direct benefit attributable to the project. This assumes the project will be the least cost alternative.

Population projections were calculated by two methods. The first method assumed that what has happened in the period 1961 to 1966 will continue to happen in the future. Increases or decreases in population will continue at the same quantitative rate. The second method takes into account the relative importance of primary industry as a generator of employment in the region. The total population is projected in relation to expected trends of employment within industries. The effect of irrigation development on future population is discussed. Projections were made to 1976 and 1986. Changes in social organization, technology, and economic conditions preclude predictions beyond this period. 42/ However, the 1986 figure should provide a reasonable estimate of future demand.

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42/ Hoyt, Homer; Growth of Cities from 1800 to 1960 and Forecasts; Land Economics Journal Vol. XXXIX, No. 2, May 1963.

The demand for domestic water by any individual is dependent upon his tastes or preferences for this product, his income and the prices he must pay for the range of quantities made available to him. Price is one of the major determinants affecting his consumption.[43/] A demand function was developed using prices and total consumption for a number of urban centres which used block pricing methods. They are retail prices. Consumption estimates are made from this demand curve.

Town costs of supplying water are difficult to come by but estimates were made for the alternatives of groundwater and water from the project. These include the costs of exploration, development and purification of existing groundwater supplies, and the costs of storage and purification of canal water. These costs are presented but are not used to measure benefits. Instead existing wholesale costs per capita were obtained for established irrigation districts in Southern Alberta. Wholesale costs per capita (retail prices - town costs) times the population served provided a measurement of the net direct benefits from water for domestic use in the distribution area.

## Evaluation of Benefits

Trends are shown in Table 17 for towns, villages, hamlets and rural populations for the project area. Rural and hamlet populations were treated as one group as neither have public provision of water distribution or sewage systems. Population data on hamlets is limited. Projections were aggregated for towns and villages. Only a general trend can be shown because any one urban centre may increase or decrease more than a simple trend would predict.

Table 18 provides 1961 employment data for Census Division #4 and Census Division #7. The breakdown by industrial category shows the relative importance of agriculture as an employer compared to other primary industries. As agriculture has such a predominant position, population projections are based on projected changes in the number of farm operators.

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[43/] Gardner, S. and B. Delworth; Factors Affecting Consumption of Urban Household Water in Northern Utah, Bulletin #449, Agricultural Experiment Station, Utah State University, Logan, Utah, 1964.

TABLE 17

## POPULATION DATA
## HISTORICAL TRENDS
## PROJECTIONS TO 1976 AND 1986
## DISTRIBUTION AREA[44/]

| Towns | 1921 | 1931 | 1941 | 1946 | 1951 | 1956 | 1961 | 1966 | 1976* | 1986* |
|---|---|---|---|---|---|---|---|---|---|---|
| Castor | 710 | 634 | 625 | 647 | 798 | 958 | 1,025 | 1,090 | | |
| Coronation | 645 | 738 | 581 | 633 | 738 | 784 | 864 | 811 | | |
| Hanna | 1,364 | 1,490 | 1,622 | 1,756 | 2,027 | 2,327 | 2,645 | 2,633 | | |
| Provost | 465 | 533 | 518 | 645 | 676 | 878 | 1,022 | 1,328 | | |
| Stettler | 1,416 | 1,219 | 1,295 | 1,499 | 2,442 | 3,359 | 3,638 | 3,988 | | |
| Wainwright | 975 | 1,147 | 980 | 1,261 | 1,996 | 2,653 | 3,351 | 3,867 | | |
| Oyen | 390 | 401 | 326 | 339 | 433 | 562 | 780 | 846 | | |
| TOTAL | 5,965 | 6,162 | 5,947 | 6,780 | 9,110 | 11,521 | 13,325 | 14,563 | 17,039 | 19,515 |
| **Villages** | | | | | | | | | | |
| Amisk | --- | --- | --- | | --- | 151 | 127 | 134 | | |
| Big Valley | 1,057 | 455 | 291 | | 307 | 354 | 461 | 378 | | |
| Botha | 130 | 107 | 111 | | 98 | 102 | 112 | 134 | | |
| Cereal | 180 | 185 | 142 | | 135 | 154 | 195 | 191 | | |
| Chauvin | 219 | 269 | 343 | | 340 | 353 | 395 | 362 | | |
| Chinook | 241 | 176 | 142 | | 116 | 154 | 114 | 95 | | |
| Consort | 166 | 299 | 265 | | 396 | 434 | 557 | 594 | | |
| Craigmyle | 231 | 236 | 186 | | 136 | 138 | 107 | 98 | | |
| Czar | 71 | 140 | 139 | | 123 | 153 | 196 | 222 | | |
| Delia | 312 | 286 | 315 | | 278 | 282 | 287 | 274 | | |
| Donalda | 248 | 169 | 206 | | 318 | 256 | 289 | 271 | | |
| Edgerton | 176 | 189 | 258 | | 309 | 292 | 295 | 345 | | |
| Gadsby | 150 | 144 | 141 | | 128 | 145 | 98 | 84 | | |
| Halkirk | 146 | 160 | 118 | | 148 | 209 | 172 | 177 | | |
| Hughenden | 173 | 191 | 164 | | 218 | 212 | 294 | 274 | | |
| Morrin | 164 | 149 | 216 | | 226 | 267 | 316 | 272 | | |
| Munson | 207 | 164 | 139 | | 78 | 82 | 82 | 39 | | |
| Rumsey | 116 | 83 | 90 | | 110 | 104 | 123 | 108 | | |
| Veteran | 157 | 180 | 190 | | 206 | 241 | 239 | 278 | | |
| Youngstown | 410 | 372 | 188 | | 352 | 305 | 321 | 357 | | |
| TOTAL | 4,554 | 3,954 | 3,644 | | 4,022 | 4,388 | 4,780 | 4,687 | 4,548 | 4,458 |
| TOTAL TOWNS AND VILLAGES | 10,519 | 10,116 | 9,591 | | 13,132 | 15,909 | 18,105 | 19,250 | 21,587 | 23,973 |
| C.D. #4 + M.D. 47 | 32,212 | 26,436 | 16,536 | | 11,997 | 12,468 | 12,671 | 11,405 | | |
| C.D. #7 - M.D. 62 | 26,513 | 26,606 | 23,243 | | 20,670 | 18,282 | 17,421 | 16,265 | | |
| TOTAL RURAL AND HAMLETS | 69,244 | 63,158 | 49,370 | | 32,667 | 30,750 | 30,092 | 27,670 | 22,826 | 17,982 |
| TOTAL POPULATION | 68,584 | 62,519 | 48,980 | | 45,799 | 46,659 | 48,197 | 46,920 | 44,413 | 41,955 |

[44/] Census of Canada, 1966. Population Statistics, Ottawa. Irma and Empress populations deleted.

* Straight line projection based on last 5 years. Aggregated from individual projections of each municipality.

These were calculated by projecting the change in acreage based on the 1961 - 66 period and determining the consequent change in number of farm operators as there is a fixed land area within the distribution system. The ratio of the total population to the number of farm operators was used to compute total population changes for 1976 and 1986. These projections are shown in Table 19. The aggregate historical trends and projections are graphed in Figure 3.

## TABLE 18

### TOTAL EMPLOYMENT BY INDUSTRY
### DISTRIBUTION AREA 1961 45/

| Primary | Census Division #4 | Census Division #7 |
|---|---|---|
| Agriculture | 2,797 | 6,874 |
| Forestry | --- | 2 |
| Fishing and Trapping | --- | --- |
| Mines, Quarries & Minerals | 73 | 354 |
| TOTAL | 2,870 | 7,230 |
| **Secondary and Tertiary** | | |
| Manufacturing | 48 | 251 |
| Construction | 164 | 552 |
| Transportation, Communication, and other Utilities | 617 | 1,091 |
| Trade and Commerce | 578 | 1,592 |
| Finance, Insurance and Real Estate | 50 | 201 |
| Service Industries | 714 | 2,000 |
| Public Administration and Defence | 120 | 917 |
| TOTAL | 2,291 | 6,604 |
| TOTAL EMPLOYMENT | 5,161 | 13,834 |

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45/ Labor Force, 1961 Census of Canada; Dominion Bureau of Statistics, Ottawa, 1964.

## TABLE 19

## POPULATION-PROJECTIONS BY AGRICULTURAL EMPLOYMENT, DISTRIBUTION AREA 1966[46]

### Census Division #4 plus Municipal District of Starland

| | 1956 | 1961 | 1966 | 1976 | 1986 |
|---|---|---|---|---|---|
| Total Land Area (Acres) | 5,552,896 | 5,555,482 | 5,675,245 | 5,675,245 | 5,675,245 |
| Number of Farm Operators | 3,174 | 2,859 | 2,566 | 2,050 | 1,710 |
| Average Farm Size Acres | 1,749 | 1,943 | 2,218 | 2,768 | 3,318 |
| Total Population | 17,998 | 18,842 | 17,550 | --- | --- |
| Ratio of Persons to a Farm Operator | 5.67 | 6.59 | 6.84 | 6.84 | 6.84 |
| Projected Total Population | --- | --- | --- | 14,022 | 11,696 |

### Census Division #7 less Municipal District of Flagstaff

| | 1956 | 1961 | 1966 | 1976 | 1986 |
|---|---|---|---|---|---|
| Total Land Area (Acres) | 3,422,031 | 3,436,548 | 3,448,856 | 3,448,856 | 3,448,856 |
| Number of Farm Operators | 4,126 | 3,676 | 3,384 | 2,906 | 2,545 |
| Average Farm Size Acres | 829 | 935 | 1,019 | 1,187 | 1,355 |
| Total Population | 29,562 | 30,213 | 30,162 | --- | --- |
| Ratio of Persons to a Farm Operator | 7.16 | 8.29 | 8.91 | 8.91 | 8.91 |
| Projected Total Population | --- | --- | --- | 25,892 | 22,676 |

---

[46] *Census of Agriculture and Population*, Dominion Bureau of Statistics, Ottawa, 1966. The total projected population for the area is 39,914 for 1976 and 34,372 for 1986.

FIGURE 3

HISTORICAL POPULATION TRENDS AND PROJECTIONS

DISTRIBUTION AREA

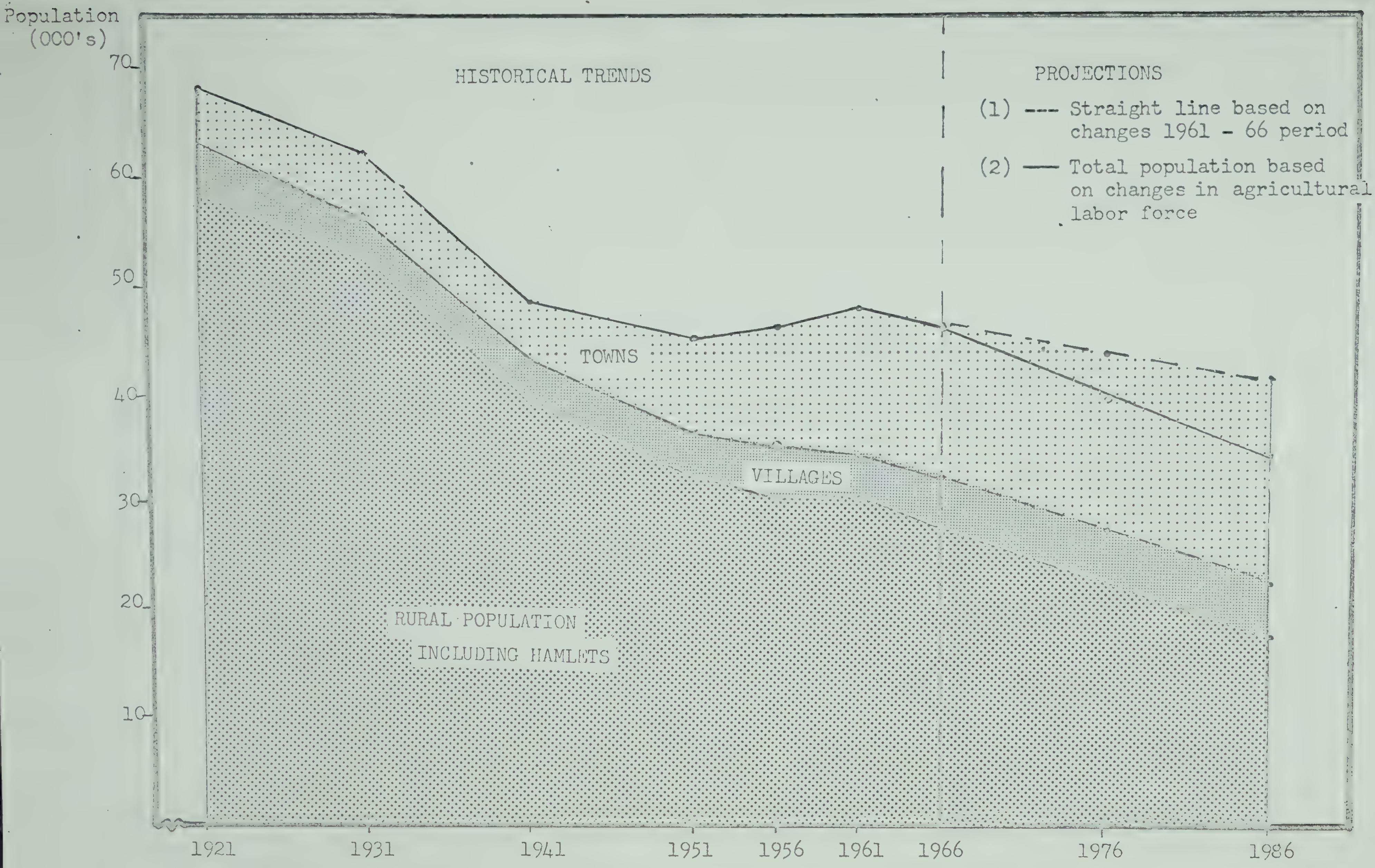

Figure 3 shows a general decline in the rural and total population since 1921. There was a rapid exodus of rural people in the period 1931 to 1941 when conditions were adversely compounded by drought and depression. Village populations have remained relatively constant over time. Town populations increased rapidly in the period 1941 to 1961. The last five years have shown a moderate increase. Straight line projections indicate a falling rural population, a slightly declining village population, and a moderately increasing town population. The increase in town population could result from three forces. These are increased activity in other primary industries such as oil, gas, and mineral development; consolidation of services in larger centres from villages; and retirement of the farm population to towns and villages.

The population projection based on agriculture alone is more severe than the straight line projection. As such it confirms the expectations of the straight line projection. However for this analysis the more moderate decline of the straight line projection will be used.

The development of irrigation within the project will increase the number of farmers in the area, assuming that the new farms will be a viable economic alternative for prospective settlers. These people would require services for selling their produce and purchasing their needs for home and farm. Therefore, an increase in the population living in towns and villages, near or in irrigation areas, would follow as a logical consequence. Allowing a thumb rule figure of 200 irrigable acres per farm, a total increase of 1,500 farm operators might be expected on a development of 300,000 irrigable acres. This in turn would result in an increase in total population for the area of 10,500 people assuming a ratio of 7 people for every farm operator.

The net increase in people to towns and villages would be less by the size of the farmers' families. Given a ratio of 3.9 rural people per farm operator the remaining 3.1 people per farm operator could be expected in town and villages. Towns and villages would thus increase in total by 4,650 people. This is a conservative estimate based on the assumption that similar production patterns will be carried out by farmers if irrigation was introduced. Specialty crops would increase this number if processing plants were established. The likelihood of this happening is discussed under irrigation benefits in Section IV.

A general approximation of the domestic water demand function for Alberta urban centres, including towns and villages in the distribution area and established irrigation districts, is shown in graphical form in Figure 4.[47] Consumption data for this curve includes household, industrial, commercial and governmental use. As such, per capita consumptions will be greater by the quantity used by categories other than households. In the smaller communities, the quantity used by households is likely to make up the major portion of total consumption. As most of the observations are those for smaller communities, the data should be fairly representative of that for domestic water.

In Figure 4, the black dots represent 1966 per capita consumption levels for the average prices charged where block rates are in effect. Open circles represent consumption levels and average revenues where flat rates are in effect. The average revenue under flat rates is simply a mathematical reflection of the water used. It does not represent a relationship between the prices charged and consumption levels. The consumer is likely to use all he can get as it costs him no more for 5,000 gallons than for 1,000 gallons.

The significance of this function is two fold. Consumption will vary with the prices charged and in as much as prices reflect costs of production and distribution, higher costs are likely to deter consumption. As price falls below the 80 cents per thousand gallon level, consumption rises proportionately faster. From $1.40 per thousand to 80 cents per thousand consumption rises by 20 gallons per capita per day. From 80 cents per thousand to 20 cents per thousand, consumption rises by 55 gallons per capita per day. Lawn watering is likely to be more prevalent at a lower price level.[48]

Table 20 shows the data used to graph the relationship between prices and consumptions.

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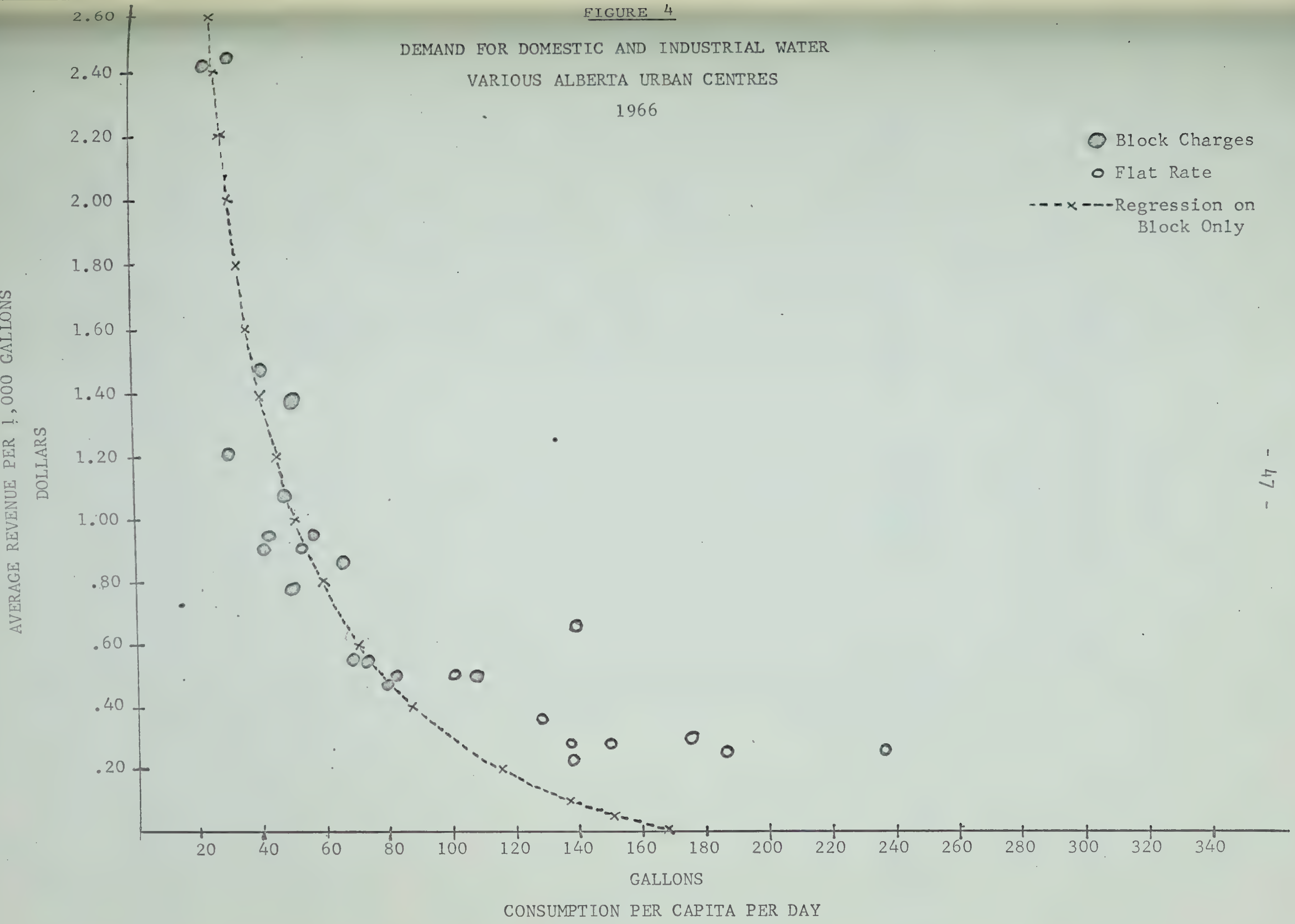
[47] Regression analysis contributed by J. Gorr and H. Bryce, Economics Division, Alberta Department of Agriculture.
The Correlation coefficient was 0.89596. The function was $Y = \frac{1}{0.0059 + 0.1371x}$

[48] Gardner, Op. Cit.

FIGURE 4

DEMAND FOR DOMESTIC AND INDUSTRIAL WATER
VARIOUS ALBERTA URBAN CENTRES
1966



## TABLE 20

## CONSUMPTION REVENUE AND EXPENDITURE INFORMATION FOR VARIOUS CITIES TOWNS AND VILLAGES IN ALBERTA [49]

1967

| Urban Centre | Population | Expenditure per 1,000 gallons $ | Revenue per 1,000 gallons $ | Consumption per Capita per Day gallons |
|---|---|---|---|---|
| | | Block Rates Distribution Area | | |
| Consort | 594 | 3.33 | 2.45 | 24.9 |
| Oyen | 846 | 2.54 | 1.48 | 41.4 |
| Provost | 1,328 | 1.24 | 1.39 | 51.6 |
| Hughenden [50] | 274 | 2.09 | 1.21 | 30.8 |
| Stettler | 3,988 | 0.83 | 0.92 | 41.2 |
| Hanna | 2,633 | 1.11 | 0.87 | 66.2 |
| Wainwright | 3,867 | 0.49 | 0.79 | 49.6 |
| | | Flat Rates Distribution Area | | |
| Cereal | 191 | 1.89 | 0.92 | 52.8 |
| Chauvin | 362 | 0.62 | 0.27 | 136.2 |
| | | Block Rates Irrigation Areas | | |
| Coaldale | 2,541 | 0.71 | 0.55 | 72.2 |
| Picture Butte | 1,013 | 0.53 | 0.50 | 107.2 |
| Brooks | 3,354 | 0.56 | 0.50 | 81.7 |

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[49] Sources: Census of Canada; Dominion Bureau of Statistics, Ottawa, 1966.
Annual Report; Department of Municipal Affairs; Edmonton, 1966.

[50] Hughenden's charges are assumed to be block rates.

Table 20 continued from page 48.

| Urban Centre | Population | Expenditure per 1,000 gallons | Revenue per 1,000 gallons | Consumption per Capita per Day gallons |
|---|---|---|---|---|
| | | Flat Rates Irrigation Areas | | |
| Vauxhall | 934 | 0.82 | 0.66 | 137.9 |
| Barons | 270 | 0.71 | 0.51 | 101.5 |
| Rosemary | 221 | 0.41 | 0.30 | 173.6 |
| Raymond | 1,950 | 0.33 | 0.28 | 148.6 |
| Duchess | 233 | 0.40 | 0.27 | 235.2 |
| Burdett | 207 | 0.40 | 0.26 | 185.3 |
| | | Block Rates Other Areas | | |
| Rockyford | 281 | 2.05 | 2.42 | 24.9 |
| Innisfail | 2,531 | 0.99 | 1.08 | 47.8 |
| St. Albert | 9,736 | 1.07 | 0.95 | 42.2 |
| Leduc | 2,856 | 1.49 | 0.95 | 54.9 |
| Red Deer | 26,171 | 0.64 | 0.56 | 69.4 |
| Edmonton | 381,230 | 0.39 | 0.48 | 79.8 |
| | | Flat Rates Other Areas | | |
| Calgary | 330,575 | 0.38 | 0.36 | 126.8 |
| Devon | 1,283 | 0.86 | 0.24 | 137.3 |

Table 20 provides insight into the reasons for variation in consumption as a result of pricing. With flat rates, consumption is generally higher than where block rates are used. General taxation is used as another source of revenue where expenditures exceed revenues. This policy would encourage consumption beyond the level consumers would adopt when they are subject to all charges through the price system. Some urban centres have made water production and distribution a profit making enterprise in 1966. Water pricing policies are thus quite variable between urban centres and are dependent on the philosophies of the local governments concerned. The

availability of a large supply of water for the spring, summer and fall at low cost is a major factor in determining the pricing policy to be used by urban centres. The majority of the urban centres in the irrigation areas have adopted a flat rate policy. Most urban centres using ground or local surface supplies have adopted a block rate pricing policy. The available supplies of ground water during summer months would be limited in comparison to water supplies from an irrigation canal. As a result of this analysis it is important to make some assumptions on pricing policies when calculating domestic water benefits.

General shifts in demand over time can be expected as a result of changes in technology and income. For example, the purchase of an automatic washer, the installation of a sewage system, or the development of a new industry will increase consumption. Increases in population will result in increased demand. As industrial activity is excluded from evaluation in this section, a domestic water use figure of 60 gallons per person per day is assumed. 51/ This assumes a block pricing policy is in effect and that there will be a modest increase in per capita consumption. Although half of the rural people do not at present use sewage facilities allowance is made for this in the estimate. The projected rural and urban population for the area was estimated at 41,955 by 1986. The increase in total population due to irrigation development was estimated at 10,500.

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51/ Schultz, W., Water Use by Economic Sector, Some Preliminary Estimates, Unpublished Paper, Department of Agricultural Economics, University of Alberta. Gross consumption per person per day in Edmonton has remained unchanged from 1935 to 1967. Almost 1/2 of Edmonton's water consumption is purchased by large industrial users. Edmonton's gross consumption in 1966 was 79.8 gallons per capita per day.

For domestic water purposes the average population over the life of the project is taken to be 52,455. Total domestic water consumption would approximate 1,200,000,000 gallons or 4,230 acre feet annually. This is net of any storage requirements or seepage and evaporation losses.

Three alternatives are available to domestic water users. These are: to maintain the status quo; to improve the quality and quantity of their present supplies; or use the project as a source when it is developed. Development costs have been estimated for ground water sources, desalination of ground water supplies and water purchased from the proposed project.[52/] Operation and maintenance costs for supplying water to the municipal distribution system have been assumed equal for both the ground water and the project situations. They have been included in desalination estimates. The costs of materials for purification where treatment plants are required were included. Capital costs have been amortized at a 5% interest rate. A twenty year life is assumed for ground water wells and a thirty-five year life for reservoirs and treatment plants. A ten year life is assumed for desalination plants. It must be emphasized that the figures presented are only "ball park" estimates. Engineers approached for cost estimates have pointed out that each situation can vary significantly in cost because of local conditions. To adequately evaluate each alternative would require engineering studies on the costs of supplying ground water and water from the project for each town and village at the same rate of production and

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[52/] Source Material from:

(1) Le Breton, Gordon; Groundwater Division, Research Council of Alberta.

(2) Kerr, Allan, Soils Geology and Groundwater Branch, Water Resources Division, Alberta Department of Agriculture.

(3) Town Secretary-Treasurers, Towns in Southern Alberta.

(4) Higo, T; Environmental Health Services, Alberta Department of Public Health.

(5) Haven's Industries Ltd. San Diego, California, U.S.A.

of the same quality. This is beyond the scope of this report as the location of the distribution system is still unknown. It is unlikely that the towns would pay for the transportation of water over long distances. An estimated capital cost of $20,000 would be incurred for every mile a town brought water from the project. Present capital costs of water supply facilities excluding the distribution system of the town range from $20,000 for a population of 100 to 200 people, to $200,000 for a population of 3,000 in irrigation areas. The number of miles that water would be piped is limited before costs of piping become equal to the present investment in water supply facilities. Under assumptions that all centres will be near the project and that all piping costs will be included in project costs, a discussion of the alternatives is still possible.

Table 21 shows estimates of the average annual capital costs of supplying ground water in the distribution area and project water in Southern Alberta to existing towns and villages.

### TABLE 21

### ESTIMATED RELEVANT ANNUAL COSTS FOR WATER SUPPLIES

| No. of Centres | Population | Average Annual Consumption gallons | Average Total Capital Cost $ | Average Annual Capital Cost $ | Purification Materials Cost $ | Total Annual Cost $ | Weighted Cost Per 1,000 Gallons Consumed $ |
|---|---|---|---|---|---|---|---|
| Project water | | | | | | | |
| 7 | 1,316 | 45,283,670 | 115,889 | 9,299 | 318 | 9,617 | 21.2 |
| Ground water | | | | | | | |
| Towns | | | | | | | |
| 7 | 2,080 | 60,748,514 | 35,407 | 2,841 | --- | 2,841 | 4.7 |
| Villages | | | | | | | |
| 15 | 260 | 7,584,213 | 15,612 | 1,253 | --- | 1,253 | 16.5 |

Ignoring differences in quality, average ground water costs are lower than those for surface water supplies from projects. The natural advantage for ground water of built-in storage requiring no treatment would support these findings. Where quality is a problem this conclusion is misleading. Table 22 shows estimates of the cost of desalinating present ground water for the villages of Youngstown, Consort and Cereal through a "reverse osmosis" process.

### TABLE 22

### ESTIMATED DESALINATION COSTS FOR THREE CENTRES IN THE DISTRIBUTION AREA

| | Population | Annual Consumption gallons | Total Annual Cost $ | Total Annual Cost/ 1,000 Gallons $ |
|---|---|---|---|---|
| Cereal | 191 | 4,558,580 | 3,789.09 | 0.83 |
| Youngstown | 357 | 9,117,335 | 7,884.22 | 0.86 |
| Consort | 594 | 13,676,185 | 8,336.00 | 0.61 |

The costs of desalinating ground water are high enough that when combined with regular town water supply and distribution costs they do not appear to be an acceptable alternative. It is possible that technical advances will improve this situation.

In lieu of data to adequately answer which alternatives would be accepted by centres and realizing that a large number of centres may be too far away from any proposed project another method must be used to measure net direct benefits attributable to domestic water.

Water purchases were recorded from towns and villages in Southern Alberta using project water as a source. Table 23 shows the annual purchases for the centres.

TABLE 23

WATER PURCHASES FROM IRRIGATION DISTRICTS [53]

1966

| Town | Population | Purchases | Annual Per Capita Outlay |
|---|---|---|---|
| | | $ | $ |
| Brooks | 3,354 | 4,200 [54] | 1.25 |
| Barons | 270 | 300 | 1.11 |
| Duchess | 233 | 374 | 1.60 |
| Picture Butte | 1,013 | 950 | 0.94 |
| Burdette | 207 | 255 | 1.23 |
| Rosemary | 221 | 282 | 1.28 |
| Coaldale | 2,541 | 1,203 | 0.47 |
| Vauxhall | 934 | 530 | 0.57 |

The weighted average annual outlay for raw water was $0.92 per capita per year.

The estimated population over the life of the project is 52,455. The expected net direct benefit annually based on present charges for raw water would be 52,455 x 0.92 or $48,258. This assumes that all the people in the project area will require water from the project for domestic purposes and that present charges in southern Alberta are realistic.

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[53] Annual Report, Alberta Department of Municipal Affairs, 1967.

[54] Estimated, as the figure for 1966 included the treatment of raw water. Personal Communication with Secretary-Treasurer for Brooks.

# Section IV

## IRRIGATION

### The Area

The general distribution area can be described by available Census Data to provide an indication of the existing land use, production patterns, and the volume of sales per farm.

TABLE 24

LAND USE IN THE DISTRIBUTION AREA

1966[55/]

| Use | Census Division #4 Acres | Census Division #4 % | Census Division #7 Acres | Census Division #7 % |
|---|---|---|---|---|
| Wheat | 540,568 | 10.0 | 858,689 | 17.7 |
| Other Cereal Grains | 145,213 | 2.7 | 462,860 | 9.5 |
| Tame and Annual Cereal Hays | 171,856 | 3.2 | 256,093 | 5.3 |
| Oilseeds | 33,060 | 0.6 | 44,043 | 0.9 |
| Other Crops | 143 | 0.0 | 510 | 0.0 |
| TOTAL UNDER CROPS | 890,840 | 16.5 | 1,622,195 | 33.4 |
| Improved Pasture | 141,369 | 2.6 | 206,408 | 4.2 |
| Summerfallow | 506,766 | 9.3 | 750,459 | 15.5 |
| Other Improved Land | 24,038 | 0.4 | 43,080 | 0.9 |
| Unimproved land | 3,506,523 | 64.7 | 1,818,829 | 37.5 |
| Total land area of Census farms | 5,069,536 | 93.5 | 4,440,971 | 91.5 |
| Total land area | 5,423,360 | 100.0 | 4,851,840 | 100.0 |

In Census Division 4, two-thirds of the land area was still in its natural state and was used for pasture for the beef animals. About one-sixth of the

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[55/] 1966 Census of Agriculture, Dominion Bureau of Statistics, Ottawa, Canada.

land was used for cereal grain production and another sixth lies fallow or produces forage for winter feeding or pasture. Wheat was the major cereal grain produced.

In Census Division #7, a larger proportion of the land area was improved leaving slightly over one-third in its natural state. One-third of the land produced cereal grains while the other third lay fallow or produced fodder.

Census Division #4 lies primarily within the Brown Soil Zone of Western Canada while Census Division #7 is mainly within the Dark Brown Soil boundaries. The change in intensity of land use from south to north reflects the variation in soils and climate. This change in productivity is reflected in the increased number of holdings in Census Division #7 compared to Census Division #4. The figures are 4,799 compared to 1,927 respectively. Thus, there were more than double the farms located on less total land area.

Table 25 indicates the major types of production carried on in the Distribution Area.

## TABLE 25

### COMMERCIAL FARMS CLASSIFIED BY PRODUCT TYPE FOR THE DISTRIBUTION AREA[56/]

| Product Type | Census Division #4 (Number of Farms) | Census Division #7 (Number of Farms) |
|---|---|---|
| Dairy | 3 | 39 |
| Cattle, hogs, sheep (excluding dairy) | 568 | 1,482 |
| Poultry | 1 | 7 |
| Wheat | 959 | 1,805 |
| Small grains (excluding wheat) | 100 | 358 |
| Field crops other than small grains | --- | 3 |
| Miscellaneous Specialty | --- | 2 |
| Mixed | | |
| Livestock Combination | 36 | 240 |
| Field Crops Combination | 17 | 40 |
| Other Combinations | 39 | 120 |
| All Classes | 1,723 | 4,096 |

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56/ 1966 Census of Agriculture, Dominion Bureau of Statistics. A farm is classed by product type if more than 50% of its sales are derived from one form of output.

In the Distribution Area, the major products produced in 1966 are wheat and beef. Depending on the year the productions would vary.

In both Census Divisions about one half of the farms sold less than ten thousand dollars worth of agricultural products. As a rule of thumb[57/] net income for farms is usually in the neighborhood of one-third of gross farm production. Consequently, farms selling less than $10,000 worth of agricultural products per year are earning roughly less than $3,000 net income per year. Comparatively in Alberta about two-thirds of the farms sold less than $10,000 worth of agricultural products. Although, the situation appears to be better in the Distribution Area than the province as a whole these statistics must be evaluated in the light of the very favorable crop yields and prices in 1966. On average, the results would show less farms above the ten thousand dollar level. Farms below this level indicate the need for increased earnings. Two avenues open are increased earnings within agriculture or supplementary earnings from off farm employment.

Table 26 shows the distribution of farms according to the volume of agricultural sales for each Census Division.

## TABLE 26

### ECONOMIC CLASSES OF COMMERCIAL FARMS WITHIN THE DISTRIBUTION AREA 1966[58/]

| Value of Agricultural Products Sold | Census Division #4 (Number of farms) | Census Division #7 (Number of farms) |
|---|---|---|
| $35,000 and over | 51 | 186 |
| $25,000 - $34,999 | 90 | 181 |
| $15,000 - $24,999 | 296 | 656 |
| $10,000 - $14,999 | 397 | 844 |
| $ 7,500 - $ 9,999 | 250 | 627 |
| $ 5,000 - $ 7,499 | 331 | 792 |
| $ 3,750 - $ 4,999 | 161 | 410 |
| $ 2,500 - $ 3,749 | 147 | 400 |
| All classes | 1,723 | 4,096 |

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[57/] 1965 Farm Business Analysis, Economics Division, Alberta Dept. of Agriculture, Edmonton.

[58/] 1966 Census of Agriculture, Dominion Bureau of Statistics, Ottawa, Canada.

Climatic comparisons provide a basis for evaluation of an area's advantages or shortcomings for the production of food products. Table 27 provides selected measures of climate for the distribution area compared to existing irrigation projects in southern Alberta.

## TABLE 27

## COMPARATIVE MEASURE OF CLIMATE[59/]

| | Distribution Area | | Southern Alberta | | |
|---|---|---|---|---|---|
| General Location by Population Centres | Viking Vulcan | Hanna Saskatoon | Lethbridge | Brooks | Medicine Hat |
| Degree Days above 42°F | 2,400 | 2,400 | 2,750 | 2,800 | 3,200 |
| Corn Heat Units | 1,600 | 1,750 | 2,000 | 2,000 | 2,300 |
| Growing Season in Days | 175 | 174 | 189 | 187 | 194 |
| Frost Free Period in Days | 100 | 95 | 120 | 110 | 125 |
| Potential Evapotranspiration in inches | 21.0 | 21.0 | 23.0 | 22.5 | 24.0 |
| Annual Precipitation in inches | 15 | 13 | 17 | 13 | 14 |
| Moisture Deficit in inches | 6 | 8 | 6 | 10 | 10 |

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[59/] Chapman, L. J., and Brown, D. M., The Climates of Canada for Agriculture - Report #3, Canada Land Inventory, Department of Forestry and Rural Development, Ottawa, 1966.

Growing degree days, a cumulative measure of the growing season increses in a southerly and easterly direction towards Medicine Hat. Corn heat units, which provide an indication of the varieties of corn which may be grown, show a similar trend. The Climates of Canada publication suggests that, "the development of new earlier hybrids would push the northern fringe of corn production towards the 1,900 Corn Heat Units line". The growing season and the frost free period are shorter in the distribution area than in southern Alberta. Potential evapotranspiration indicates the inches of moisture that would be transpired through plants and evaporated from the soil when moisture is not a limiting factor. Annual precipitation is self-explanatory. The lower half of the distribution area from Hanna east has as little precipitation as any of those shown for southern Alberta. The moisture deficit, the inches of water short of requirements for ideal cropping conditions, is present in all areas. These shortages exist upon the assumption that the soil can

only store four inches of moisture for use prior to the growing season. Comparatively, the distribution area is in a better position than south eastern portions of the province but has similar or larger deficits than the Lethbridge-Taber area. Taber, thirty miles east of Lethbridge has a soil moisture deficit of eight inches. Edmonton, far to the north, has a deficit of four inches.

Table 28 provides data on the amounts of water used by crops in the Taber-Vauxhall area under irrigation and the length of the growing season for these crops.

## TABLE 28

## SEASONAL CONSUMPTIVE USE OF WATER BY CROPS GROWN UNDER IRRIGATION CONDITIONS[60]

| Crop Type | Seasonal Mean Consumptive Use (Inches) | Length of Growing Season (Days) |
|---|---|---|
| Alfalfa | 25.5 | 155 |
| Grass | 23.6 | 152 |
| Sugar Beets | 21.5 | 156 |
| Potatoes | 19.9 | 137 |
| Hard Wheat | 18.2 | 102 |
| Oats | 16.1 | 96 |
| Barley | 16.1 | 90 |
| Flax | 15.2 | 98 |
| Field Corn | 14.7 | 120 |
| Tomatoes | 14.4 | 103 |
| Canning Peas | 13.4 | 78 |

Seasonal consumptive use data indicates that with the present annual precipitation in the distribution area crops do not have sufficient moisture to achieve maximum growth.

Soils and topography within the tentative boundaries of the distribution area are the key to the quality, quantity and type of irrigation development which may be undertaken. Present investigations are being

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[60] McKay, G.A., Climatological Studies, Number 1, Department of Transport, Ottawa, 1963.

conducted by the Soils, Geology and Groundwater Branch and the Land Development Branch of the Water Resources Division. In this past year full detailed studies of soils were completed at eleven locations covering fifty thousand acres. Topography assessments cover 988,640 acres. This work is being conducted outside of the boundaries of the William Pearce study proposed by the Prairie Farm Rehabilitation Administration in the early nineteen fifties. Soils investigations were completed for this area.[61/] Within the William Pearce Scheme 374,500 acres were evaluated. One hundred and forty thousand acres belong to the Hemaruka class. The summary conclusion of the Youngstown Report sheds general light on the quality and quantity of irrigable soils within this particular area.

> "In brief, the Hemaruka soils of the Wm. Pearce scheme are unsuitable for irrigation in the forseeable future. The soil survey report indicates that other soils in the irrigable area closely resemble the Hemaruka. The conclusions, respecting Hemaruka soils apply in lesser degree to them. Still other soils, while suitable for irrigation, occur in such small areas and in such intimate association with Hemaruka that they must also be ruled out. When these factors are considered, and in addition topography, availability of water, surface drainage, and salinity, it is evident that larger areas of good irrigable soils in the Wm. Pearce project are few and far between".

Investigations outside this area have not as yet reached the stage where such broad conclusions can be laid down but similar problems have been encountered to some degree.

In summary, the distribution area is located in a semi-arid area where moisture is a major limiting factor to crop production. As a consequence, extensive land use patterns predominate. Major agricultural products produced include wheat and beef. Known areas of irrigable soils are limited in relation to the wide boundaries initially established for investigation.

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[61/] Bowser, W.E., Report on the Soil Survey of the William Pearce Irrigation Project, included in the Youngstown Irrigation Experiments Report, Toogood, J.A., Soils Science Department, University of Alberta, 1963.

## The Hypothesis

Irrigation, the application of water to land by man made means will increase the productivity of crops grown in the distribution area. The magnitude of the net direct benefit is dependent upon the increase in productivity, the change in inputs required to raise the productivity and the area over which the water will be applied.

## Procedure

For purposes of this analysis, direct benefits are considered as the increases in productivity from the land. They are limited to the cropping programs on the land. In most analyses increases in "on farm" production are considered as direct and usually include changes in livestock production as well as crop production. However, this analysis will not include livestock production as a direct benefit. Rather the crops grown for livestock use will be valued at their market price and as such the livestock industry will be paying for the products of the field crop industry, as if its existence were not interwined with individual farm ownership which incorporates the complementarity of the two enterprises under one roof. The adoption of this approach is a direct result of the constraints placed on this analysis. Data which is not readily available cannot be gathered and applied before knowledge of defined areas of potential irrigation are known. Useable data from secondary sources could be adjusted on a crop enterprise basis with greater ease than for a farm as a whole. The danger in this approach is that on both the input and output side, more assumptions have to be made about the pricing of products, which do not have a sufficient volume of transactions to be certain that the price used reflects the actual value of the commodity for most buyers and sellers concerned. As well, the assumptions on farm size, enterprise combinations and their complementary nature, labor use, and joint use of inputs between enterprises are all taken, as given, fixed by prior situations as laid down in existing studies. However, as this approach has simplicity as a major attribute it is considered to be the best for this analysis.

To determine direct benefits, two budgets are required. The first is a statement of the gross returns and total costs that exist under the present land use pattern without the project. The second is an evaluation of the gross return, total costs and residual return to water that would occur annually under a land use pattern with irrigation supplied. The difference between these two budgets will yield a measurement of the net direct benefit to the project.

## Evaluation of Benefits

In lieu of the actual number of acres, which will be irrigable, estimates are presented. A range of 200,000 to 400,000 irrigable acres is still under consideration. These acres are not likely to be located in one large block providing maximum density. Rather there are likely to be very small blocks of irrigation dispersed at random through a much greater acreage of range land. Budgets are presented for an aggregation of all these smaller areas for 200,000, 300,000 and 400,000 acres.

Land use under irrigation is expected to be tied to the growing of conventional crops such as cereals and forage. The reasoning for such a development is justified on the grounds that this is by far the major use of irrigated land in existing irrigation districts. Eighty-four percent of the irrigated land in 1963 was producing conventional crops such as cereal grains, hay and pasture or lying fallow.[62/] Only sixteen percent produced such crops as sugar beets, oil seeds, vegetables, potatoes and forage seeds. The majority of this acreage is located in the southern and eastern irrigation areas where soil, and climate provide an absolute advantage for the production of these crops. Processing industries established in this area are likely to expand here first. Irrigable acreage is not a factor limiting the increased production of specialty crops in these areas and as a consequence the feasibility of the Red Deer Basin Development is going to depend on cereal and forage production under the irrigated situation.

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[62/] Allen, L.C., and K. Elgaard, Irrigation Lands Crops Production Study, All Irrigation Districts, Alberta, 1963, Canada Department of Agriculture, Edmonton.

Table 29 shows the estimated land use patterns for dryland and irrigation situations for the distribution area. The land use under dryland is taken from an actual survey of ranchers within the boundaries of the old William Pearce Scheme.[63] Land use under irrigation is adapted from an annual census of the Eastern Irrigation District.[64]

## TABLE 29

## ESTIMATED LAND USE PATTERNS DRYLAND AND IRRIGATION SITUATIONS

| Description of Crops | Dryland | | | Irrigation | | |
|---|---|---|---|---|---|---|
| | 200,000 acres | 300,000 acres | 400,000 acres | 200,000 acres | 300,000 acres | 400,000 acres |
| Wheat | 5,600 | 8,400 | 11,200 | 23,800 | 35,700 | 47,600 |
| Oats | 3,200 | 4,800 | 6,400 | 19,000 | 28,500 | 38,000 |
| Barley | 1,000 | 1,500 | 2,000 | 23,400 | 35,100 | 46,800 |
| Rye | 800 | 1,200 | 1,600 | 400 | 600 | 800 |
| Mixed Grain | --- | --- | --- | 6,200 | 9,300 | 12,400 |
| Flax | --- | --- | --- | 10,800 | 16,200 | 21,600 |
| Cereal Hay | 3,200 | 4,800 | 6,400 | 3,600 | 5,400 | 7,200 |
| Tame Hay | 10,600 | 15,900 | 21,200 | 56,800 | 85,200 | 113,600 |
| Silage | --- | --- | --- | 1,600 | 2,400 | 3,200 |
| Tame Pasture | 5,200 | 7,800 | 10,400 | 35,400 | 53,100 | 70,800 |
| Total Crop Acres | 29,600 | 44,400 | 59,200 | 181,000 | 271,500 | 362,000 |
| Summerfallow | 6,000 | 9,000 | 12,000 | 19,000 | 28,500 | 38,000 |
| Total Cultivated Acres | 35,600 | 53,400 | 71,200 | 200,000 | 300,000 | 400,000 |
| Breaking | 200 | 300 | 400 | --- | --- | --- |
| Native Hay | 1,600 | 2,400 | 3,200 | --- | --- | --- |
| Unimproved Land | 162,600 | 243,900 | 325,200 | --- | --- | --- |
| Total Acres | 200,000 | 300,000 | 400,000 | 200,000 | 300,000 | 400,000 |

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[63] Economics Division, East Central Alberta Water Development Survey, Alberta Department of Agriculture, 1967.

[64] Eastern Irrigation District, Annual Census for 1962 to 1966, Brooks, Alberta.

## Estimated Gross Returns and Total Costs
## Dryland Situation

Gross returns under present dryland conditions are calculated by summing the products of acreage times yield times price for each land use and weighting these by the total number of acres involved to provide a weighted return per acre.

Under dryland conditions, returns and costs were calculated in a two stage approach. Gross returns and total costs were estimated for the cultivated acreage. The second stage involved the estimation of a net return to range land under unimproved conditions. The net returns in both instances were combined for use in determining the net direct benefits accruing to the project.

Table 30 shows the computations for estimating the gross returns per cultivated acre under dryland conditions in the project area.

### TABLE 30

### ESTIMATED GROSS RETURNS PER CULTIVATED ACRE
### DRYLAND SITUATION

| Description of Crop | Acres (200,000 acre situation) | Yield per Acre | Price per Unit $ | Gross Returns $ |
|---|---|---|---|---|
| Wheat | 5,600 | 11.0 bus. | 1.63 | 100,408 |
| Oats | 3,200 | 13.8 bus. | 0.60 | 26,496 |
| Barley | 1,000 | 18.1 bus. | 0.96 | 17,380 |
| Rye | 800 | 7.7 bus. | 1.09 | 6,712 |
| Cereal hays | 3,200 | 0.70 tons | 18.00 | 40,320 |
| Tame hay | 10,600 | 0.34 tons | 22.00 | 79,288 |
| Tame pasture | 5,200 | 0.34 tons | 11.00 | 19,448 |
| Total crop acres | 29,600 | | | |
| Summerfallow | 6,000 | | | |
| Total cultivated acres | 35,600 | | | |
| Value of Native & Slough hay | 1,600 | 0.34 tons | 22.00 | 11,968 |
| Total Gross Returns | | | | $ 302,020 |
| Gross Returns per cultivated acre | | | | $ 8.48 |

Yields were computed from field surveys for 1966. Grain yields were adjusted to reflect longterm average yields on the basis of Census data for the period 1946 to 1966 for Census Division #4 and a ten year record of yields for Grain Research Laboratory areas within the census division. Forage yields were estimated on the basis of the one year field survey. The low tame hay yield can be explained in part by the management practice of a "take half-leave half" rotation.

Prices for grains were estimated on the basis of reported prices at the lake head less freight for long term average grades received in Census Division #4. A five year price period was selected beginning in 1962. Forage prices were estimated from a series of studies conducted by the Economics Division for both farm management and cost determination purposes. Pasture prices are based on the cost of harvesting being one half the purchase price of harvested forage.[65/]

The value of native hay is included as no possibility existed for separation of costs between native hayland and cultivated acreages.

Estimated total costs of production per cultivated acre under the dryland situation are presented in Table 31.

TABLE 31

ESTIMATED TOTAL COSTS OF PRODUCTION PER CULTIVATED ACRE
DRYLAND SITUATION

| Description | $ per Cultivated Acre |
|---|---|
| Direct variable costs | 0.99 |
| Joint variable costs | 2.18 |
| Total variable costs | $ 3.17 |
| Total fixed costs | 3.94 |
| Labor | 1.09 |
| Total Costs | $ 8.20 |

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[65/] McBain, B.J., results of long term "Cost of Production Studies for Fluid Milk Producers", Economics Division, Department of Agriculture, Edmonton, Alberta.

The data for Table 31 were obtained from a survey of 28 farms in the distribution area in 1967.[66] Direct variable costs include expenses incurred for crop sprays, fertilizer, purchased and home grown seed, twine, and custom work. Joint variable costs include those incurred for; the farm portion of operating a car, gas, oil, grease and repairs for trucks, tractors, and machinery, tools and hardware and repairs to buildings. As the data was taken largely from income tax statements licenses and insurance costs which are normally classified as fixed costs are included under joint variable costs. Fixed costs included depreciation and interest on assets such as land, buildings, machinery, and inventory of feed and supplies and charges for taxes, telephones and power. Joint variable costs and fixed costs were split according to the share of the total cost that was incurred by the crop enterprise. Labor costs were valued at $2,400 per year. Respondents estimated by week the time spent on crops versus other enterprises on the farm. Interest was charged at 5%, depreciation rates were charged through at fifteen percent for power equipment, ten percent for other equipment and five percent on buildings. No allowances were made for management. The difference of $0.28 between gross returns and total costs could be considered as a residual return to management.

For native pasture a net return of $0.51 per acre has been calculated in Section V. This return has been adopted for this analysis.

## Estimated Gross Returns and Total Costs
## Irrigation Situation

Gross returns with irrigation are estimated for each crop produced and weighted according to the expected acreages sown. Total costs of production were estimated from two studies conducted in irrigation area.

Table 32 shows the calculations for gross returns with the irrigation.

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[66] Ibid 63.

## TABLE 32

## ESTIMATED GROSS RETURNS PER CULTIVATED ACRE IRRIGATION SITUATION

| Description of Crop | Acres (200,000 Acre Situation) | Yield per Acre[67] | Price per Unit $ | Gross Returns $ |
|---|---|---|---|---|
| Wheat | 23,800 | 35.4 bus. | 1.63 | 1,373,308 |
| Oats | 19,000 | 63.1 bus. | 0.60 | 719,340 |
| Barley | 23,400 | 46.7 bus. | 0.96 | 1,049,069 |
| Rye | 400 | 21.7 bus. | 1.09 | 9,461 |
| Mixed Grain | 6,200 | 47.0 bus. | 0.78 | 22,729 |
| Flax | 10,800 | 14.1 bus. | 3.02 | 459,886 |
| Cereal hay | 3,600 | 2.5 tons | 18.00 | 162,000 |
| Tame hay | 56,800 | 2.5 tons | 22.00 | 3,124,000 |
| Silage | 1,600 | 7.5 tons | 6.00 | 72,000 |
| Tame Pasture | 35,400 | 2.5 tons | 11.00 | 88,500 |
| Total Crop Acres | 181,000 | | | |
| Summerfallow | 19,000 | | | |
| Total Cultivated Acres | 200,000 | | | $7,080,293 |
| Gross Return per Cultivated Acre | | | | $ 35.40 |

Adjustments: - Increased yields due to levelling (120%)[68]

Decreased yields due to poorer soil (87.4%)[69]

Estimated Gross Return per Cultivated Acre $ 37.12

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[67] Annual Census, Eastern Irrigation District, Brooks, Alberta 1962-66 average.

[68] Miller, R.J., Economics of Land Levelling, Economics Division, Alberta Department of Agriculture, 1968.

[69] Annual Census, Eastern Irrigation District. Yield differences based on similar soils to the project area.

Total costs estimates are presented in Table 33.

### TABLE 33

### ESTIMATED TOTAL COSTS OF PRODUCTION PER CULTIVATED ACRE IRRIGATION SITUATION[70]

| Description | Acres | $ per cultivated acre | $ 000's |
|---|---|---|---|
| Dryland acres | 113,000 | | |
| Irrigable acres | 190,600 | | |
| Total Cultivated acres | 303,600 | | |
| Direct variable costs | | 3.32 | |
| Joint variable costs | | 5.48 | |
| Total variable costs | | 8.80 | |
| Fixed costs | | 11.32 | |
| Labor costs | | 5.92 | |
| Total crop costs | | 26.04 | |
| Total crop Costs | | | 7,907 |
| Estimated dryland crop costs[71] | | | 1,710 |
| Irrigation crop costs | | | 6,197 |
| Irrigation crop cost per cultivated acre | | 32.51 | |
| Adjustment for reduced interest for lower land costs | | 0.96 | |
| Estimated cost of production per cultivated acre | | $31.55 | |

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[70] Roger, Manning and Grubb, The Economic Benefits and Costs of Irrigation in the Eastern Irrigation District of Alberta. University of Alberta, Edmonton, 1966. Data was revised to crop enterprise base on basis of studies on Colonization Farms, conducted by S. Lee, Economist, Water Resources Division, Alberta Department of Agriculture, Lethbridge.

[71] Saskatchewan Farm Business Summary - Five Year Average cost of $15.13 per cultivated acre, Extension Report No. 9, Saskatchewan Department of Agriculture, Regina, 1965.

Costs include similar items to those under the dryland situation. As the data from irrigation study costs was composed of both dryland and irrigated acreages, adjustments were required to separate out the costs of the irrigated cropland. Dryland costs in the Brooks area are not necessarily the same as those in the survey area. Land suitable for dryland use is usually a lower quality irrigation soil. Clay soils are best for dryland. Sandy loam soils are better for irrigation purposes. The costs used for adjustment were adopted through comparison of similar dryland values of thirty dollars per acre. By subtracting an estimated dryland cost from the total cost for both irrigation and dryland production a residual was computed for irrigation. This value adjusted for changes in land values was taken as the irrigation cost per acre. Labor was valued at $2,400 per year. Interest was charged at five percent.

## Estimated Annual Net Direct Benefits for Irrigation

Table 34 shows the estimated annual net direct benefits for three sizes of irrigation development and two assumed values of the farmers' labor. No allowances were made for management.

## TABLE 34

## ESTIMATED NET DIRECT BENEFITS FOR IRRIGATION

## DISTRIBUTION AREA

| Description | Labor @ $2,400 per year | | | | | |
|---|---|---|---|---|---|---|
| | Dryland | | | Irrigation | | |
| | 200,000 ac. | 300,000 ac. | 400,000 ac. | 200,000 ac. | 300,000 ac. | 400,000 ac. |
| Gross Returns | $ 301,888 | $ 452,832 | $ 603,776 | $ 7,424,000 | $11,136,000 | $14,848,000 |
| Total Costs | 291,920 | 437,880 | 583,840 | 6,310,000 | 9,465,000 | 12,620,000 |
| Net Return to Cultivated Acreage | 9,968 | 14,952 | 19,936 | 1,114,000 | 1,671,000 | 2,228,000 |
| Net Return to Rangeland | 82,926 | 124,389 | 165,852 | --- | --- | --- |
| Total Net Return Above Costs | $ 92,894 | $ 139,341 | $ 185,788 | $ 1,114,000 | $ 1,671,000 | $ 2,228,000 |
| Irrigation less Dryland | | | | 92,894 | 139,341 | 185,788 |
| Annual Net Direct Benefits | | | | $ 1,021,106 | $ 1,531,659 | $ 2,042,212 |

| | Labor @ $3,600 per year | | | | | |
|---|---|---|---|---|---|---|
| | 200,000 ac. | 300,000 ac. | 400,000 ac. | 200,000 ac. | 300,000 ac. | 400,000 ac. |
| Gross Returns | $ 301,888 | $ 452,832 | $ 603,776 | $ 7,424,000 | $11,136,000 | $14,848,000 |
| Total Costs | 311,144 | 466,716 | 622,288 | 6,984,000 | 10,476,000 | 13,968,000 |
| Net Returns to Cultivated Acreage | - 9,256 | - 13,884 | - 18,512 | 440,000 | 660,000 | 880,000 |
| Net Returns to Rangeland | 82,926 | 124,389 | 165,852 | --- | --- | --- |
| Total Net Return Above Costs | $ 73,670 | $ 110,505 | $ 147,340 | $ 440,000 | $ 660,000 | $ 880,000 |
| Irrigation less Dryland | | | | 73,670 | 110,505 | 147,340 |
| Annual Net Direct Benefits | | | | $ 366,330 | $ 549,495 | $ 732,660 |

The selection of which annual net direct benefit figure to use depends on a specific irrigable acreage figure being adopted and on what return to labor is considered adequate for the farmers involved. The relevancy of the net direct benefits to existing water rate charges can be shown by comparing the net direct benefits per irrigated acre to present water rates in established irrigation districts. At a $2,400 per year labor rate for irrigation, the net direct benefits are $5.10 per irrigable acre. At the $3,600 per year labor rate, the net direct benefits are $1.88 per irrigable acre. Present water rates range from $1.15 to $3.00 in existing major projects.[72/] Estimated water costs for operation, maintenance and replacement in these projects has ranged from $2.03 to $5.79 per irrigable acre in major projects.[73/]

## Development Period

Benefits on an annual base have been computed as if the project was built instantaneously. To provide an indication of time period involved, from the day water is first used in a project until all the irrigable acreage is irrigated, Table 35 is presented.

### TABLE 35

### DEVELOPMENT PERIOD

### EASTERN SECTION - ST. MARY AND MILK RIVERS DEVELOPMENT[74/]

| Year | % Irrigated of Irrigable | Year | % Irrigated of Irrigable |
|---|---|---|---|
| 1966 | 63.5 | 1958 | 48.6 |
| 1965 | 57.3 | 1957 | 40.0 |
| 1964 | 93.3 | 1956 | 20.7 |
| 1963 | 91.5 | 1955 | negligible |
| 1962 | 87.9 | 1954 | " |
| 1961 | 80.0 | 1953 | " |
| 1960 | 67.0 | | |
| 1959 | 55.4 | | |

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[72/] Annual Reports, Irrigation Districts, Alberta 1967.

[73/] Annual Costs of Irrigation Districts, Alberta Regional Engineering Division. Prairie Farm Rehabilitation Administration, Engineering Branch, Canada. Department of Agriculture, Calgary, Alberta 1967.

[74/] Graham, J.H., Records of the St. Mary and Milk Rivers Development Corp., Lethbridge, Alberta.

1953 was the first year water was available to the Eastern section. 1965 and 1966 were years with high rainfall and can be discounted for this reason. Development therefore extended over a nine to eleven year period. For budgeting purposes a ten year period can be assumed. A linear increase of 10% per year would not be out of line with actual practice. The application of these results to other areas is reasonable as the acreage developed was over 100,000 acres.

# Section V

## STOCKWATER

### The Area

As mentioned in Section IV, one major land use is grazing of unimproved range, within the general boundaries of the distribution area. The proportion of unimproved range for each municipal district is shown for 1961 in Table 36. Aggregate figures for Census Division 4 and 7 are given for 1961 and 1966. The acreage in unimproved range has remained relatively constant over this period.

TABLE 36

PROPORTION OF UNIMPROVED RANGE [75/]

| Division or Sub Division | 1961 Unimproved Range | Total Area | % Unimproved Range |
|---|---|---|---|
| Acadia Valley #34 | 119,951 | 277,572 | 43.2 |
| Special Area No. 2 | 1,564,972 | 2,023,485 | 77.3 |
| Special Area No. 3 | 1,785,023 | 2,634,787 | 67.7 |
| Starland #47 | 186,534 | 619,638 | 30.1 |
| Stettler County #6 | 449,062 | 967,773 | 46.4 |
| Paintearth County #18 | 362,532 | 773,944 | 46.8 |
| Provost #52 | 411,937 | 884,549 | 46.6 |
| Wainwright #61 | 378,247 | 830,372 | 45.6 |
| Census Division #4 1961 | 3,469,946 | 4,935,844 | 70.3 |
| Census Division #4 1966 | 3,503,016 | 5,069,536 | 69.1 |
| Census Division #7 1961 | 1,914,477 | 4,434,321 | 43.2 |
| Census Division #7 1966 | 1,762,136 | 4,440,971 | 39.7 |

The extensive nature of land use, especially within Census Division #4, is the result of climate. The beef cow becomes an all important factor in harvesting the grass where yields are relatively low. Rated carrying capacities range from 32 acres per animal unit per year in Census Division 7, to anywhere from 40 to 50 acres per animal unit per year in Census Division 4.[76/] Livestock numbers by Census Division are reported in Table 37.

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[75/] 1961 and 1966 Census, Dominion Bureau of Statistics, Ottawa.

[76/] Map of Grazing Zones, Department of Lands and Forests, Alberta 1966.

## TABLE 37

## LIVESTOCK NUMBERS [77]

June 1st 1966

| Category | Census Division #4 | Census Division #7 |
|---|---|---|
| Beef Cows | 90,993 | 117,533 |
| Calves | 75,273 | 109,913 |
| Bulls | 3,922 | 5,807 |
| Beef Steers & Heifers | 39,489 | 75,400 |
| Cows & Heifers for Milk | 2,818 | 15,599 |
| Total Cattle and Calves | 212,495 | 324,252 |
| Cattle on Feed January 1st 1966 | 13,495 | 66,855 |
| Total Pigs | 8,445 | 58,017 |
| Total Sheep | 10,746 | 6,318 |
| Total Hens & Chickens | 108,846 | 386,437 |
| Total Turkeys | 1,922 | 16,501 |

The major livestock operation in this area is beef production. The major beef enterprise produces calves and yearlings for sale as feeders from unimproved land in Census Division #4. Census Division #7 has more feeding within its boundaries. A larger proportion of acreage is under cultivation which would result in more feed grains being available for finishing cattle and hogs. [78]

At present stock water is being provided from three sources. These are local spring runoff, local ground water and "live" [79] rivers or streams. Surface runoff is collected by lakes or sloughs, dams, and dugouts. Groundwater is developed by drilling wells, constructing "live" dugouts and improving existing springs.

Stock water requirements can be divided between the range and the farmstead. Farmstead needs are largely satisfied from ground water sources. Peak

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[77] 1966 Census, Dominion Bureau of Statistics, Ottawa.

[78] Discussions with District Agriculturists and Field Surveys.

[79] "live" for purposes of discussion is considered as "a continuous flow of water through all seasons of the year in all years."

requirements occur during the winter feeding months. The majority of range needs are met by dugouts and dams.[80/]

Two reasons for the undeveloped state of ground water supplies out on the range can be hypothesized. Investment costs are higher for wells than for dugouts. The total cost of construction for a well one hundred feet deep has been estimated at $1,180.00.[81/] Actual average well construction costs and depths for stock use in the these survey areas have run at $569.80 for 81 feet; $521.25 for 125 feet and $377.93 for 70 feet.

Records of well depths have been recorded. On the basis of estimates, the average depth of wells located in surficial glacial deposits called drift, was 17 feet. The estimated average depth of wells located in bedrock was 125 feet. The average depth for 1300 wells located in both types of formations is estimated at about 100 feet.[82/] Construction costs on a dugout have been estimated at $621.25. The net cost to the rancher has been estimated at $471.25.[83/] In two cases, at least, well development costs are equal to or greater than the cost of a dugout to the rancher.

Although no statistical evidence is available it is apparent that a well on the range would require a storage tank to hold water, more supervision on the part of the rancher, and additional operation costs for pumping of the water. These observations when combined with differences in capital costs of development favor the construction of dugouts over wells on range.

Surface water supplies are dependent on runoff. The median annual runoff for the area is shown on a map on page 76. The quantity of runoff decreases from north-west to south-east. Within the distribution area's boundaries, the lowest runoff isoline of 20 acre feet per square mile still

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[80/] Extrapolation from the Stock and Domestic Water Survey, G.B. Parlby and the Stock Water Inventory, C.L. Primus. Unpublished Data, Economics and Water Resources Divisions, Alberta Department of Agriculture.

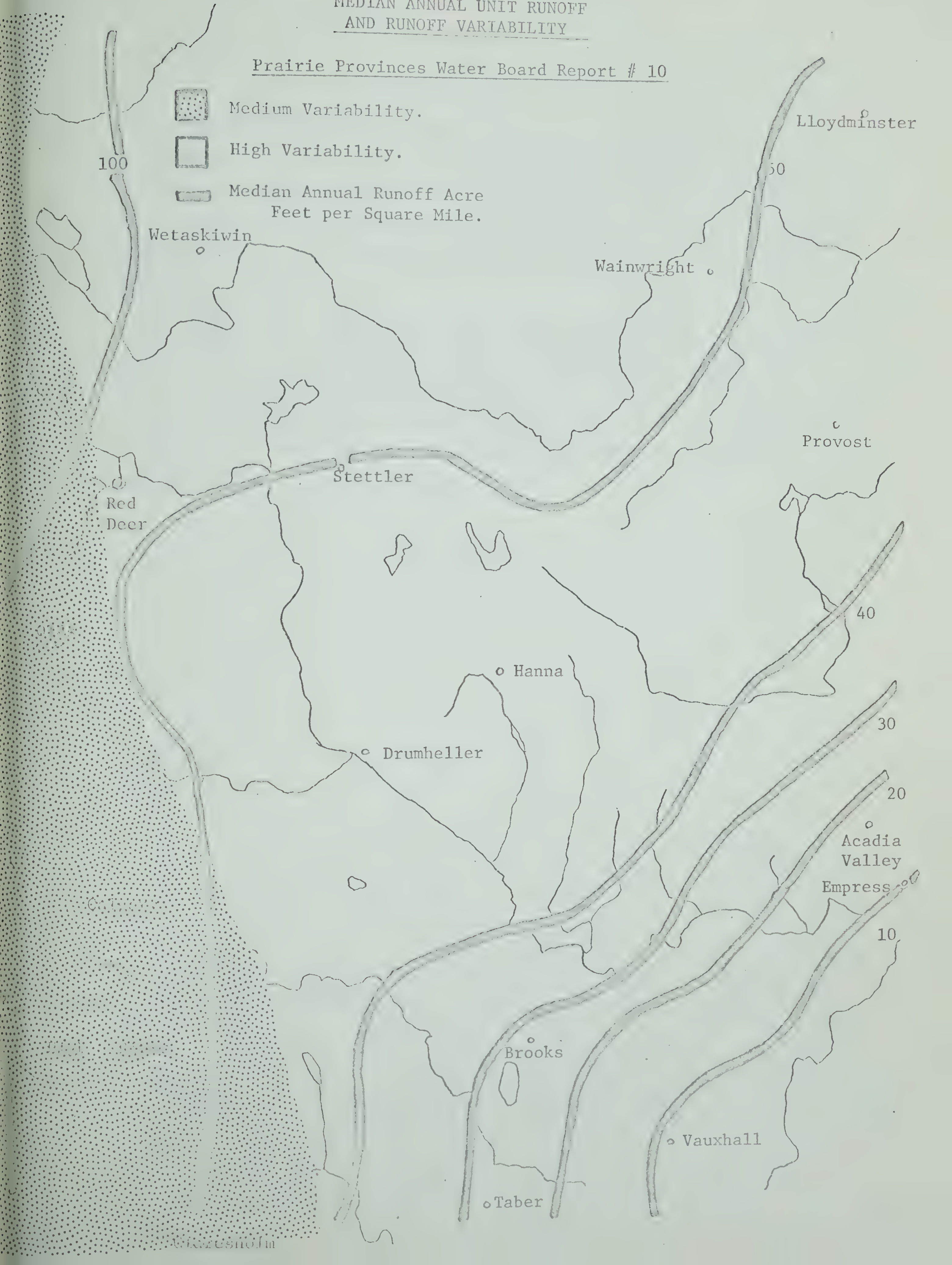
[81/] Bowman D., Groundwater Branch, Water Resources Division, Alberta Department of Agriculture. Costs are broken down as follows: Test hole and Design $150; Drilling Water Well $250; Casing @ $2 per ft. $200; Screen & fittings $95. Cementing $25; Development @ $10 per hr. $100; Test Pumping - 6 hrs. $60; Permanent Pump $300. Total Cost $1180.

[82/] Ibid 80.

[83/] Prairie Farm rehabilitation Office Edmonton. dugout Specifications - 200' x 65' x 14'. Excavation of 3,550 cubic yards of earth. Average cost of earth moving 17.5¢ per cu. yd. P.F.R.A. shares cost @ 7¢ per cu. yd. Total cost $621.25. Net to rancher $471.25.

## MEDIAN ANNUAL UNIT RUNOFF AND RUNOFF VARIABILITY

Prairie Provinces Water Board Report # 10



would allow for filling of a dugout holding 2 acre feet with a drainage of 64 acres. The variation around the median is significant. Failures of dugouts in the past can be related to very little runoff in a specified year. The area under investigation thus has a low median runoff compared to areas closer to the mountains and as well, the runoff varies more from year to year.

In summary, the distribution area being considered has a large proportion of unimproved range, whose major use is production of beef calves. Water for stock on range is supplied largely through the collection and storage of surface runoff. The median runoff pattern in the area shows a decrease from north-west to south-east. The whole area is subject to high variations in runoff from year to year.

## The Hypotheses

The distribution system by means of natural channels would provide a supply of water for all stock on range in the area. Specific details of the mechanics of water transportation to the range are to be worked out in final proposals. For the present, this analysis is based on the hypothesis that it is physically possible to serve all unimproved range land.

Two benefits are probable. The first would result from an optimum distribution of water supplies over the unimproved range land. As a result stocking rates could equal present rated carrying capacities. Where stocking rates already equal carrying capacities, improved utilization of existing grass through uniform grazing may be of further benefit. As this analysis is concerned with the resource, water, it ignores the potential improvement from range re-seeding. It is possible that the greatest improvement in range productivity could come through this avenue.84/

The second benefit from water for stock on the range results from the high variability in local runoff. Losses have been incurred in years of low runoff when surface water supplies have failed. Water from the distribution system would act as an insurance program against cyclical shortages. Savings in losses result in income to the rancher. In years when water supplies fail, the effect can be very dramatic. The more frequent the failures, the larger the losses incurred, and as a result, the greater benefit received.

The benefits, therefore, may be hypothesized as two-fold. One is dependent on increased productivity. The other results from the insurance value of water for stock in drought years.

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84/ Research Experiments, Lethbridge Experimental Farm, Lethbridge, Alberta.

## Procedure

In evaluating the stock water benefits of the distribution area, three approaches could be adopted to determine the extent to which benefits occur. A blanket approach using secondary sources of data would allow budgeting of benefits without any concern for regional variation. Secondly, a budget approach verified by field surveys could be used. Thirdly, a random sampled survey according to location over the whole area, could provide data to evaluate the benefits.

The second approach was adopted for this analysis. A stock water inventory [85/] was completed for townships south of Township 37, east of Range 15 and includes the Special Areas and the Municipal District of Acadia #34. The inventory classified 201 townships as deficient, marginal or adequate. By township, the volume of water available in dams, dugouts, and wells was evaluated. The number of animal units that could be watered from this supply for a period of 8 months was calculated. A 2 year life without recharge was assumed for dugouts. No allowances were made for natural water bodies or streams. The number of animal units that could be served by these water supplies was compared to the number that could be carried on unimproved range, given the rated carrying capacity converted to an 8 month basis. Natural water facilities along Sounding Creek, confirmed by field checking, resulted in reclassification of some of these townships. Based on these assumptions 54.7% of the townships were classified as adequate; 28.4% were marginal (10% surplus of surface water) and 16.9% were inadequate. No distinct pattern of shortages developed. However, the north-western portion was generally marginal to adequate. The incidence of townships with inadequate volumes of water for the potential numbers of stock which could be carried increased from north to south.

The stock water inventory demonstrated that there are townships within the distribution area which could benefit from increased water supplies. The benefit would result from an increase in productivity as hypothesized.

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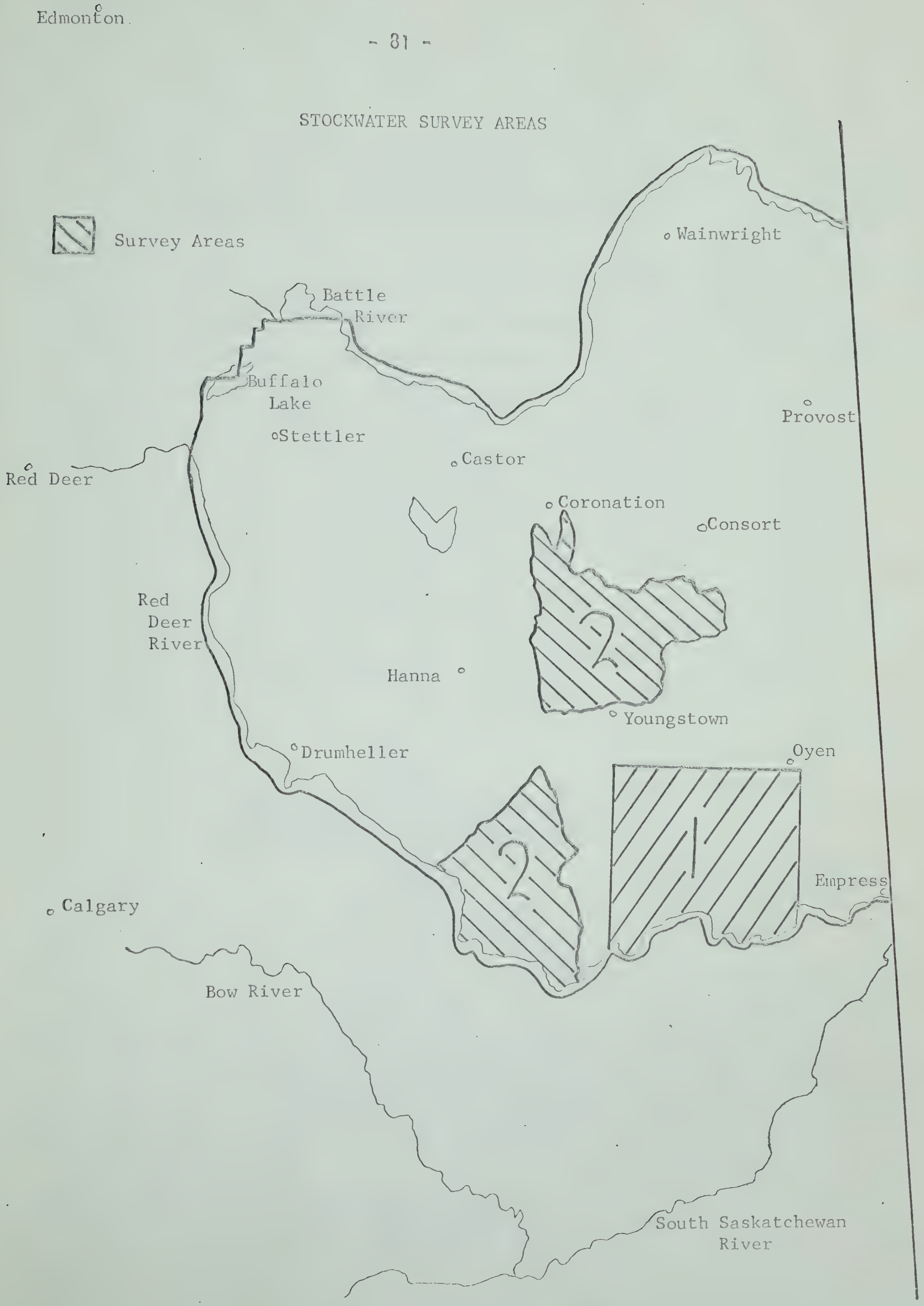
[85/] Primus, C.L. "Stockwater Inventory "Unpublished Data 1966. Water Resources Division, Alberta Department of Agriculture.

The inventory while identifying townships that had the greatest need for more stock water to increase the range productivity does not indicate which source of supply, local or external, would achieve this end.

On the basis of the stock water inventory, a field survey to gather data on shortages was carried out as shown by Area #1 on the map on page 81. A second survey was taken in conjunction with a questionnaire for irrigation development in Area #2. The areas surveyed were located where annual median runoff is low, and land use is very extensive indicating large proportions of unimproved land.

STOCKWATER SURVEY AREAS



## Evaluation of Benefits

### Benefits from Increased Range Productivity

Where there are inadequate water facilities to meet the demands of livestock which could be stocked according to rated carrying capacities, long term shortages would result. Logical consequences are over and under grazing on the range or a reduction in stocking rates.

Over and under grazing may be detected by the average number of acres served by a water facility. An accepted criterion for distance to water on the range is 3/4 to 1 1/2 miles. A water facility serving 1 mile in all directions would serve 2,011 acres.[86/] Table 38 indicates that on average all ranchers had sufficient water facilities to more than meet this accepted criterion. It also indicates that there is an increase in the ratio of grass and cows to stock water supplies from small to large herds. This may be explained in part by the existing land tenure and in part by farmstead supplies on small versus large units. Two separate sections of grazing land would require 2 water facilities. Adjoining sections would need only one.

TABLE 38

ACRES SERVED BY A WATER FACILITY
SOUTH PORTION SPECIAL AREA #3 1966

| Group Size | Range Animal Units | Acres Per Water Facility |
|---|---|---|
| Small | 0 - 49 | 392 |
| Medium | 50 -105 | 692 |
| Large | 106 and over | 1,277 |

Thus, the area should not be subject to over and under grazing if surface supplies in present facilities were adequate. Individual instances still might occur. Figure 5 on page 83 shows the relationship between

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[86/] $A = \pi r^2$ $\qquad A = \frac{22}{7} \times \frac{(5,280\ \text{ft.})^2}{43,560\ \text{ft./acre}} = 2,011$ acres.

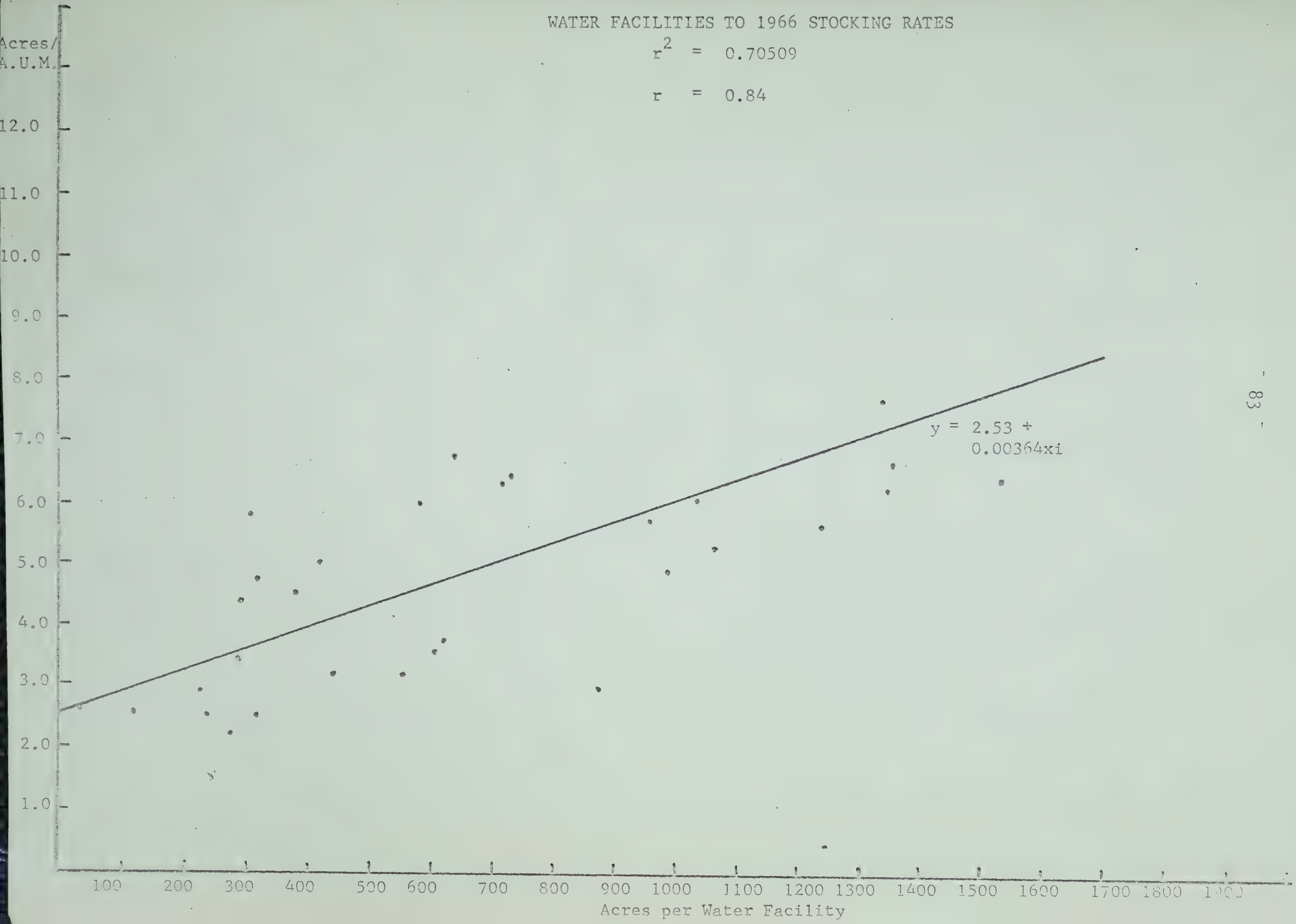
FIGURE 5

SIMPLE CORRELATION SHOWING THE RELATIONSHIP

WATER FACILITIES TO 1966 STOCKING RATES

$r^2 = 0.70509$

$r = 0.84$



stocking rates in 1966 on unimproved range and the number of acres served by a water facility. As the average acreage served per water facility increases, the number of acres used to carry an animal unit month in 1966 increases as well. Without considering any other factors this simple correlation indicates that more water facilities might result in increased stocking rates for some respondents. The crucial question is whether this benefit can be attributed to the Red Deer River Basin Development.

Ranchers have recognized the need for more water facilities. Table 39, below, shows the rate of development of water facilities in Area #2. There has been a 60 to 80% increase in the number of water facilities in the last ten years. Most of these are dams and dugouts. This may have been, in part, a response to the dry conditions which existed from 1961 to 1964. As well, the influence, both in technical advice and through direct assistance of the Prairie Farm Rehabilitation Administration, has encouraged surface water supply development.

TABLE 39

PROGRESS IN WATER DEVELOPMENT

FOR STOCK TO 1967 - SURVEY AREA #2

| NORTH PORTION: | Prior to 1956 | 1956 - 1961 | 1962 - 1967 |
|---|---|---|---|
| | - Period of Construction - | | |
| Total % of Dugouts | 17.5 | 36.1 | 46.4 |
| Total % of Stock water Dams | 33.3 | 16.7 | 50.0 |
| Total % of Wells | 50.0 | 50.0 | 0.0 |
| Total % of Facilities | 22.8 | 34.7 | 42.5 |
| SOUTH PORTION: | | | |
| Total % of Dugouts | 31.7 | 33.3 | 35.0 |
| Total % of Stock water Dams | 45.0 | 25.0 | 30.0 |
| Total % of Wells | 90.9 | 9.1 | 0.0 |
| Total % of Facilities | 41.8 | 28.5 | 29.7 |

This development further supports the position that storage of local runoff on the range is the best alternative.

Two major factors, one managerial, the other physical, could be hypothesized to explain why an area had an inadequate water supply. Respondents may have decided not to construct more water facilities because there were insufficient returns to recover the required investment, or higher rates of return for capital might be available through other alternatives elsewhere on the ranch. Physical restrictions may have eliminated the possibility of construction of any further water facilities. Thus ground water might be unavailable or there may be a lack of sites for the collection of surface water.

To determine why areas had inadequate storage, an opinion survey of ranchers was carried out. Respondents were asked why more water facilities had not been put in. In Area #1, only four of the 47 replies said they would benefit from an outside source and, of these, three had an option of resorting to ground water supplies as an alternative. In Area #2, only one of 74 respondents would receive any benefit from an outside source such as the Red Deer River in developing long term water supplies. In many cases the ranchers felt that there would be an improvement in their stocking rate on their present range as a result of actions which they could take themselves to develop increased water storage capacity.

In years, where there is adequate runoff to fill surface facilities, little benefit from the Red Deer River Basin Development is likely through improving the productivity of the range by eliminating over and under grazing or increasing the stocking rate.

## Benefits from Correcting Local Runoff Failures

The present dependency on dugouts and dams in the distribution area is significant. Surface storage facilities within the area of the stock water inventory make up 65% of the total. With the high variability in local runoff there have been years when surface supplies have failed. The last period remembered by ranchers in the area was during the drought of 1960 to 1964.

The effects of a stock water shortage are masked by the individual and group actions of ranchers to correct the problem. As well, in a drought, there is a reduction in growth of forage on the range. Losses are likely to be a result of the combined effect of grass and surface water shortages. In the areas surveyed, ground water sources have not been known to fail as a result of a drought.[87/] Individual dugouts and dams are likely to fail at varying times over a drought period because of their particular locational characteristics. These include varying rates of seepage and evaporation loss, the presence of ground water seepage or drainage area serving the dugout.

A number of events can be expected.[88/] The failure of even a small proportion of the surface supplies can result in over and under grazing. This in turn, may affect the potential of the range in future years. Weight losses can be expected on the calf crop as the distance from water to grass increases. Cows may walk farther to grass putting a stress on their calves. The milk supply of the cow may be reduced. Range land, because of land tenure, may be unuseable for the rest of the season. Winter grazing areas may be used during the summer necessitating increased feeding the following winter. Ranchers may sell yearlings and calves earlier than usual accepting a lower gross revenue per animal. Breeding herds may be culled at a higher than normal rate. Finally, in the most severe cases, death losses may be incurred.

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[87/] Domestic water survey - Unpublished Data, Economics Division for areas #1 and #2.

[88/] Based on interviews in survey area.

Depending on the resources and management of the individual, expenditures may be made to avoid the effects of shortage. These might occur at any stage as the shortage increases. Ranchers have taken preventative measures which include the development of ground water supplies by drilling new wells, construction of dugouts to increase surface supplies in another year, and the pumping of water to dugouts from large storage reservoirs through assistance from the Prairie Farm Rehabilitation Administration.

The response to a stock water shortage by any individual is likely to be a combination of the acceptance of some loss and some preventative expenditures. This response will vary as well with the severity of the shortage of runoff by year and the number of consecutive years over which the shortage occurs. The proportionate dependency on surface supplies as opposed to ground water will also affect the severity of shortage. Where ranching operations are supplementary to grain or mixed farming, unimproved range holdings are likely to be small. The dependency on surface supplies might be augmented by the well at the farmstead providing the range is less than 1 1/2 miles away.

This discussion points out the types of response to shortages taken by ranchers in the last drought in the survey areas. They are pointed out to illuminate the difficulties of measuring the benefits of stock water. Aggregation of individual losses and/or savings in expenditures to prevent losses, to provide a statement of total benefits is subject to some degree of error considering not only the variation of conditions within a drought area but as well the variation in severity between droughts. Only one drought period 1960-64 is remembered with sufficient clarity to provide data on losses or expenditures. Consequently to place any evaluation on the benefits, some other system is required.

By using records of available runoff, the number of years over a 53 year period in which dugouts and stock water dams would be short of water was estimated. The number of months the dugouts would be short was estimated as well, which provides an indication of the severity of shortage.

The assumptions upon which Figure 6 and Table 40 were based are as follows:[89]

"1. Runoff data from Berry, Bullpound, Blood Indian and Alkali Creeks are representative of the Sounding and Ribstone Creeks in the north where little data is available.

2. The average drainage area to supply a 2 acre-foot stock water storage facility is taken to be 100 acres. Runoff per square mile in Berry Creek was converted to runoff per 100 acres to calculate the amount of runoff available.

3. There exists a 2 acre-foot stock water facility per section. All runoff per 100 acres up to 2 acre-foot will be collected in the storage facility. Any runoff in excess of 2 acre-foot per 100 acres will be lost as surface flow.

4. One acre-foot of water will be used per year from each 2 acre-foot storage facility. Major evaporation and consumption occurs during the summer. Therefore, the one acre-foot withdrawn is used during 8 months, April through November. Monthly loss equals 0.125 acre-foot.

5. The last 0.5 acre-foot of water stored is not useable for stock water."

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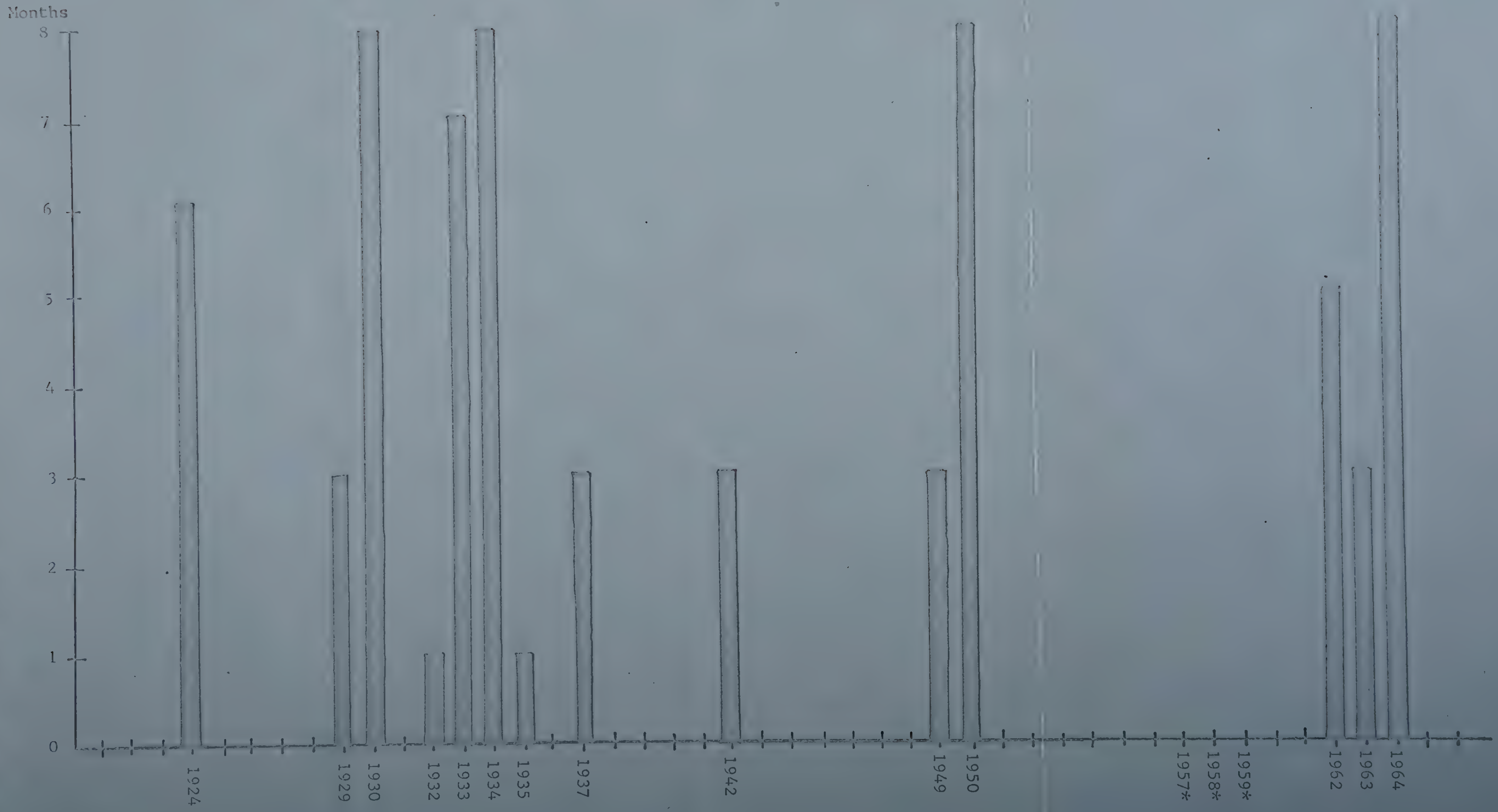
[89] Primus, C.L. "Stock Water Failure Pattern" Unpublished Data, Water Resources Division, Alberta Department of Agriculture.

FIGURE 6

OCCURENCE AND SEVERITY OF STOCK WATER SHORTAGES



* No data available

## TABLE 40

## ESTIMATED SEVERITY OF SHORTAGE

## 1911-56, 1960-66

| Months Short | % of Time Short |
|---|---|
| | 53 Years |
| 1 | 3.78 |
| 3 | 9.43 |
| 5 | 1.89 |
| 6 | 1.89 |
| 7 | 1.89 |
| 8 | 7.55 |

The severity of shortage by months provides a basis upon which an evaluation of benefits can be made. Assuming no preventative action on the part of ranchers, the range land served by surface supplies alone would not be grazed for any months when a shortage occurs.

Two methods of valuing the range land are presented. The first is based on the present value of pasture as computed through existed rental and tax charges and a computed return to land reflected by its sale price. The second is based on the dry feed value of forage and includes the costs of harvesting the feed through mechanical methods rather than through the cow.

Present pasture charges for the Special Areas are calculated on the basis of the following formula. [90/]

$$\text{Rent \& Taxes} = \frac{250 \text{ lbs.} \times P}{G.C.} \times \text{Royalty}$$

250 lbs. = estimated yield of beef
P = the weighted average price of beef on the Calgary Market for the period July 1 - December 31, of the preceeding year.
G.C. = number of acres to carry one animal unit (cow and calf, or equivalent) for 12 months (acres per A.U. year).
Royalty = 16 2/3 percent of the forage value per acre for Central Alberta. This represents the portion for rent and taxes.

Table 41 provides the prices for the last ten years used by the Department of Lands and Forests.

## TABLE 41

### WEIGHTED AVERAGE PRICES OF BEEF

### 1957 - 1966

| Year | Price per lb.<br>¢ |
|---|---|
| 1966 | 17.46 |
| 1965 | 17.98 |
| 1964 | 20.77 |
| 1963 | 23.14 |
| 1962 | 19.56 |
| 1961 | 18.31 |
| 1960 | 20.02 |
| 1959 | 21.53 |
| 1958 | 14.95 |
| 1957 | 14.06 |
| 10 year average | 18.78 |

The average carrying capacity for the Special Areas is estimated at 44 acres per A.U. per year. [91/]

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[90/] Alberta Department of Lands and Forests - Established to compute pasture charges on public lands in the Province of Alberta. These rates include payments in lieu of local government taxes.

[91/] Primus, C.L., Stockwater Inventory - Unpublished Data Water Resources Division 1966. In 1966 on an 8 months grazing period a yearly stocking rate was 46.6 acres per A.U., based on Census Division 4. Dominion Bureau of Statistics, Ottawa.

Thus a 10 year average charge per acre in the Special Areas can be established as follows:

$$\text{Rent \& Taxes} = \frac{250 \text{ lbs.} \times 18.78 \times 16\ 2/3}{44 \text{ acres/A.U./year}} = 17.79¢ \text{ per Acre}$$

Assuming that any return to pasture above the charges assigned by Special Areas Board would be bid into the sale price for lease land, an additional return to pasture can be estimated by the following formula.

$$\text{Capitalized Value of Pasture} = \frac{\text{Annual net returns}}{\text{Interest Rate}}$$

Land values were obtained from several sources. Respondents surveyed in Area #2 reported an average asking price on grazing lease land of $9.17 per acre. Actual sale values were provided by the Special Areas Board during the period November 1962 to May 1967. All lands averaged $9.12 per acre. Grazing lands averaged $5.29. These sales included buildings, fence and water improvements. There were 45 sales over this period. An arbitrary value of $7.50 for grazing lands is assumed. It is also assumed that 12 per cent of this value is apportioned to pasture improvements such as fences and dugouts.[92/] Therefore, the value of grazing land leases is estimated at $6.60 per acre. The annual return, at a five per cent interest rate, to provide a capital value of $6.60 is $0.33 per acre.[93/] The value of pasture based on opportunity costs under normal conditions is estimated at 33 + 18 = 51¢ per acre. The average carrying capacity has been calculated at 44 acres per animal unit per year for the year. The value of pasture can be expressed on an animal unit month basis as

$$\frac{44 \text{ acres} \times 51¢/\text{acre}}{1 \text{ A.U.} \times 12 \text{ months}} \quad \text{or} \quad \$1.87 \text{ per Animal Unit per Month}$$

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[92/] Thomson, G., Costs of Private Pastures in Saskatchewan - 1964. Special areas Community Pasture investment in improvement areas was 48.5¢ per acre. Annual Report, 1966, Special Areas Board.

[93/] $\text{C.V.} - \frac{\text{A.R.}}{i} \therefore \text{A.R.} = \text{C.V.} \times i = \$6.60 \times \frac{5}{100} = \$0.33$

This compares to private pasture rental charges varying from $2.00 to $3.50 per A.U.M. in regions where cost studies have been carried out.[94] This value for pasture is assumed as a minimum value.

In a year where surface supplies are limited it could be assumed that there is no available pasture for rent as every rancher to some degree is likely to experience a shortage. It is possible to hypothesize a maximum value for pasture by valuing it at the cost of replacement through dry feed. This assumes that the rancher would replace the pasture for his herd by feeding dry feed near an adequate ground water supply. It must be pointed out that ranchers did not do this during the 1960's drought in the areas surveyed. The 1960's drought therefore indicates a value less than the one being established now under these assumptions.

Prairie hay closely approximates the native range land. The amount of prairie hay to meet the nutrient requirements of a milking 1,000 lb. of beef cow and for its calf at foot are calculated below, along with the costs per Animal Unit Month, in Table 42.

## TABLE 42

## DRY FEED EQUIVALENT VALUE OF PASTURE

| | Daily Intake | Protein | Total Digestible Nutrients | Cost/lb. | 30 Day Period |
|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | | |
| Minimum Cow Requirement[95] | 28 | 1.4 | 12.4 | | |
| Prairie Hay | 28 | 1.43 | 12.6 | 1¢ | $ 8.40 |
| Oats for Calf[95] | 3 | | | 2¢ | $ 1.80 |
| Total Cost A.U.M. | | | | | $10.20 |

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[94] McBain, B.J., Dairy Cost Studies, Rental Charges used by Cost Studies.

[95] Animal Industry Division, Alberta Department of Agriculture.

This value would approximate good grazing conditions on the range. In drought years, in addition to water shortages, the production of grass is lower. To attribute the full feed value in a drought year to a lack of water would over-state the situation. Ranchers in Survey Area #2 estimated very roughly that the reduction in weaning weights on calves would be due to the lack of water and grass on an equal basis. The maximum value for forage on range land in a dry year is estimated at $5.10 per A.U.M.

By converting unimproved range within the distribution area to animal unit months of grazing and applying the values of forage established, the frequency of pasture loss, and the percentage of range dependent on surface water facilities a minimum and maximum saving in losses can be calculated. Under the assumption that no preventative actions are taken by ranchers, these savings can be considered an estimate of the minimum and maximum net direct benefit accruing to ranchers, through a stabilized surface water supply from the Red Deer River Basin Development. Tables 43, 44, and 45 present this information.

## TABLE 43

## ESTIMATED ANIMAL UNIT MONTHS OF GRAZING SERVED BY SURFACE WATER FACILITIES

| Portion of Distribution Area | 1961 Unimproved Range (Acres) | Estimated Carrying Capacity (acres/A.U./year) | Total A.U.M. of Grazing on an 8 month basis (A.U.M) * |
|---|---|---|---|
| Census Division 4 | 3,469,946 | 44 | 118,293 |
| M.D # 47 | 186,534 | 32 | 8,744 |
| County # 6 | 449,062 | 32 | 21,050 |
| County # 18 | 362,532 | 32 | 16,994 |
| M.D. # 52 | 411,937 | 32 | 19,309 |
| M.D. # 61 | 378,247 | 32 | 17,730 |
| TOTALS | 5,258,258 | | 202,120 |

Per cent A.U. served by surface water equals 65 per cent

A.U.M. A.U.M. served by surface water $202,120 \times \frac{65}{100} = 131,378$

---

* $\frac{\text{Acres unimproved range}}{\text{Rated carrying capacity}} \times \frac{12 \text{ months}}{8 \text{ months}}$

## TABLE 44

## ESTIMATED AVERAGE ANNUAL SHORTAGE EXPRESSED IN ANNUAL UNIT MONTHS

| Total A.U.M.'s | Months Short | % of Time | A.U.M.'s short Annual Basis |
|---|---|---|---|
| 131,378 | 1 | 3.78 | 4,966 |
| 131,378 | 3 | 9.43 | 37,167 |
| 131,378 | 5 | 1.89 | 12,415 |
| 131,378 | 6 | 1.89 | 14,898 |
| 131,378 | 7 | 1.89 | 17,381 |
| 131,378 | 8 | 7.55 | 79,352 |
| | | | 166,179 |

## TABLE 45

## ESTIMATED NET DIRECT BENEFITS AND ANNUAL VALUE PER A.U. YEAR

| Range | A.U.M. Short | Value of Pasture | Net Direct Benefit or Savings | Value per A.U. Year. 8 month Basis (÷ 131,378) |
|---|---|---|---|---|
| Minimum | 166,179 | 1.87 | $310,755 | 2.36 |
| Maximum | 166,179 | 5.10 | $847,513 | 6.45 |

The estimated annual net direct benefit for stockwater lies between $310,755 and $847,513 for the whole area. This range hinges on a number of assumptions which are open to further investigation. It is felt however that they do reflect the present problem of cyclical shortages of surface water, which is serious in one out of five years in the area. They assume that water will be transported to water facilities which are sparsely located over the range land. Project costs should include the cost of this transportation before these benefits can be attributed to the project.

# Section VI

## INDUSTRIAL WATER AND POLLUTION ABATEMENT BENEFITS

Information was gathered on the potential for industrial water and pollution abatement benefits arising from the Red Deer River Basin Development. These took the form of general inquiries into the changes which may be expected as a result of the project.

### Industrial Water

An inventory of the natural resources within the distribution area, was carried out from secondary sources to determine what is available, what quantities are being produced, what are the present reserves and what uses they are put to. An analysis was made of whether the industries producing the raw resource would require water in their production processes.

The known basic resources within the distribution area include common salt, sodium sulphate, bentonite,sulphur, natural gas liquids, natural gas, oil, coal, and soil. Salt is produced by pumping hot water into the salt beds and pumping out the brine. The salt is extracted from the brine. As salt is in such a plentiful supply in a large portion of Alberta, water cannot be considered a limiting factor to its production. In the production of sodium sulphate some water is required in washing but local supplies are considered sufficient for deposits at Metiskow and Cairns. Bentonite does not require water in its production process. Sulphur is produced from hydrogen sulphide in natural gas. There are sulphur extraction plants near Nevis. Water supplies from local sources are considered adequate for production purposes. Natural gas liquids and natural gas do not require water for their production. Some water is used in reflooding oil fields. Local water supplies are considered adequate for this purpose. There is no direct use of water in the production of coal. An as yet undetermined effect for the project is the use of coal at Sheerness for the production of thermal power. Water from the project would enhance the chances of establishing this plant but would

be no guarantee as there are other locational factors to be considered such as distance to markets. The soil potential for irrigation has been discussed under Section IV.

The general tenant gleaned from these observations is that the realization of large benefits is limited with regard to industrial water use within the distribution area. References for the statements on resources and their potential need for water are presented at the end of this section on page 98.

## Pollution

Known sources of pollution along the Red Deer River include the Towns of Rimbey, Bentley and Blackfalls whose lagoon effluents are discharged periodically into the Blindman River, the cities of Red Deer and Drumheller and the town of Empress which discharge their treated sanitary wastes into the Red Deer River and two gas processing plants located near Nevis who use the Red Deer River for disposal of their waste water. At present only the City of Red Deer has any limit placed upon the amount of pollutant they can discharge into the river.96/

Any benefits from upstream reservoirs that would stabilize flows and consequently increase the amount of waste that could be put into the river are at present limited to the City of Red Deer. The City of Red Deer is allowed to put 3800 lbs. of B.O.D.97/ per day in the river based on a minimum recorded flow of 70 cubic feet per second. If the minimum flow was increased to 2000 cubic feet per second a limit of 100,000 lbs of B.O.D. per day would be considered within reason. Table 46 shows the present and expected populations, volumes of sewage waste, and expected costs to be incurred without the project for the City of Red Deer.98/

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96/ Masuda, A., Water Pollution Control Engineer, Environmental Health Services Division. Memo January 8, 1968, Department of Public Health, Edmonton..

97/ Biological Oxygen Demand (B.O.D.) is a measure used to determine the amount of pollutant in a water body.

98/ Deck, N.J., City Engineer, City of Red Deer, Correspondence February 29,1968.

## TABLE 46

## PROJECTED POPULATION, WASTES, AND COSTS OF POLLUTION ABATEMENT FOR THE CITY OF RED DEER

| Year | Population | B.O.D. (Raw) lbs per day | Additional Capital Costs | Annual Operating Costs |
|---|---|---|---|---|
| 1967 | 26,000 | 12,790 | --- | $ 4,200 |
| 1968 | --- | --- | $ 160,000 | $ 7,000 |
| 1972 | 35,000 | 16,800 | --- | --- |
| 1975 | 37,500 | 19,150 | $ 80,000 | $25,000 |
| 1977 | 40,000 | 20,900 | --- | --- |
| 1980 | --- | --- | $ 120,000 | $30,000 |
| 1987 | 50,000 | 29,000 | --- | --- |

With the stabilization of flows at the 2000 c.f.s. level, and approval from the Department of Public Health, the City of Red Deer would not have to incur these costs. As such, they would be a benefit to the project. The 1968 expenditures are unlikely to be included as they will be made before the project would be initiated.

Both industrial water use and pollution abatement require more investigation before the magnitude of their benefit can be evaluated, thus only indications have been provided in this section.

### Reference List for Industrial Water Use

# 1. Industrial Minerals of Alberta, Research Council of Alberta, Report #58-2.

# 2. Alberta Industry and Resources, 1964, Alberta Bureau of Statistics, Department of Industry and Development.

# 3. Minerals for the Chemical and Allied Industries, S.J. Johnstone, Publisher: John Wiley & Sons Inc. 1954.

# 4. Reserves of Crude Oil, Gas, Natural Gas Liquids and Sulphur, Province of Alberta, Oil and Gas Conservation Board, Report for year ending December 31, 1966.

# 5. An Analysis of the Sulphur Industry in Alberta, Research Council of Alberta, Report #38.

# 6. *An Analysis of the Liquified Petroleum Gas Industry in Alberta*, Research Council of Alberta, Report #29.

# 7. *Catalogue of Coal Mines of the Alberta Plains*, Research Council of Alberta, Report #64-3.

# 8. *Annual Report of the Mines Division of the Department of Mines and Minerals*, 1966, 1965.

# 9. *Royal Commission on the Coal Industry of Canada*, 1945.

#10. Research Council of Alberta, Report #34.

#11. A Statistical Analysis of Census Division #7, Alberta Bureau of Statistics.

#12. Letters from various oil companies re: Water supplies for re-flooding.

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